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Proposed Wastewater Treatment Facilities Lower Missouri River Basin, St. Louis, Missouri

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Kansas City, MO

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Environmental effects of alternatives to abate wastewater pollution in the Lower Missouri River Basin's three watersheds: Creve Coeur, Fee Fee, and Lower Bonhomme, in St. Louis County were evaluated. Three basic alternatives were considered: (1) No Action; (2) Subregional; (3) The applicant-proposed Regional. Both the regional and subregional alternatives would result in long-term water quality improvement, and would have minor impact on the growth pattern of this approximately 80%-developed study area. No alternative preference stated in the draft.

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Environmental Impact Statement

Draft

Proposed Wastewater Treatment Facilities

Lower Missouri River Basin; St. Louis, Missouri

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DRAFT
ENVIRONMENTAL IMPACT STATEMENT
ON
LOWER MISSOURI RIVER BASIN
WASTEWATER MANAGEMENT FACILITIES

U.S. ENVIRONMENTAL PROTECTION AGENCY
KANSAS CITY, MISSOURI

AUGUST 1981

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Environmental Science & Engineering, Inc.

St. Louis, Missouri

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EXECUTIVE SUMMARY

Existing Problem

The Metropolitan St. Louis Sewer District (MSD) has submitted to the EPA a construction grant application for wastewater management facilities in the Fee Fee Creek/Creve Coeur Creek/Bonhomme Creek/Missouri River floodplain portion of its northwest service area. The MSD's proposed regional collection, transmission, and treatment facilities are needed to prevent pollution associated with raw sewage leakage and overflows in residential and other areas, backups in homes and bypasses to surface waters, and inefficient and undersized treatment plants. The problem thus constitutes a health hazard as well as a source of environmental pollution. A solution has been proposed, and an alternative action developed. The purpose of this document is to identify and characterize the environmental impacts of the MSD's Proposed Action and alternatives (including no action) for wastewater management.

Alternatives, Impacts, and Possible Mitigation

Proposed Action

The MSD's Proposed Action is a regional plan which would include new and replacement construction of sewer lines in the Fee Fee Creek and Creve Coeur Creek watersheds, which are almost completely urbanized and fully populated. In addition, sewer service would be provided to the relatively minor existing industrial development in the Missouri River floodplain, but would be extended to neither the Creve Coeur Lake area (currently being considered by St. Louis County for its commercial/industrial development potential), nor the sparsely populated Bonhomme Creek watershed. The Proposed Action would also include a new 27 million gallon per day (mgd) conventional step aeration treatment plant, at the present Missouri River Wastewater Treatment Plant site, to replace the existing 10 mgd contact stabilization plant and to treat sewage flow from the Bonfils Creek watershed northeast of the study area, the Caulks Creek Interim Wastewater Treatment Plant (presently in the final design stage) and various small, decentralized public and private sewage treatment facilities.

Alternatives

The No Action Alternative would involve continuation of the operation and maintenance of deteriorating and overloaded wastewater collection, transmission and treatment facilities. The Subregional Alternative would involve essentially the same collection and transmission improvements as would the Proposed Action. In terms of wastewater treatment, the Subregional Alternative would include the upgrading and expansion of the Missouri River Wastewater Treatment Plant to a contact stabilization capacity of 20 mgd, and retention of the Caulks Creek Wastewater Treatment Plant as a permanent facility.

Impacts on Natural Environment

Impacts on the natural environment would include effects in the areas of geology, hydrology, water quality, aquatic habitat, vegetation, wildlife, prime agricultural land, air quality, noise, energy, and solid waste. Geological impacts may include sink collapse occurrences during construction or maintenance, and localized slides, slumps, or erosion related to construction or induced development. Hydrological impacts may include minor floodplain intrusion for treatment works, and slight increases in flash flood potential near streams, with related decreases in groundwater and root zone recharge. Water quality, aquatic habitat, vegetation, wildlife, prime agricultural land, air quality, and noise levels may be adversely affected during construction on a localized and short-term basis. The foregoing types of impacts may all be substantially mitigated through the use of proper design and construction practices, as described in this document. Some petroleum-derived energy may be consumed, and solid waste may be generated. The construction impacts would be greatest in the case of the Proposed Action, less with the Subregional Alternative, and least or nonexistent with the No Action Alternative. However, over the long term, water quality, aquatic habitat, and air quality would be significantly improved through pollution abatement with either the Proposed Action or the Subregional Alternative. The Proposed Action also offers the potential for total energy conservation through its planned use of digester gas to generate electricity and heat for in-plant use.

Impacts on Social Environment

Impacts on the social environment would be largely limited to the potentially developable areas consisting of the Creve Coeur Lake area, the Bonhomme Creek watershed, the Missouri River floodplain, and the Caulks Creek watershed which is adjacent to the study area. However, major new sewer service to these areas is not presently under consideration by MSD. Based on the history of growth in and around the study area, the provision of coordinated sewer service is neither a prerequisite nor an important limiting factor regarding development. However, the Proposed Action would include the abandonment of the Caulks Creek Interim Wastewater Treatment Plant, whose physical presence could be used to support further development in the Bonhomme Creek, Caulks Creek and/or Missouri River floodplain areas. Economically, the direct costs of the Proposed Action and Subregional Alternative are similar, and significantly greater than the cost of No Action. However, the No Action Alternative involves the indirect costs of continued and increased pollution and related adverse effects on health and welfare.

Conclusion

In conclusion, both the Proposed Action and the Subregional Alternative offer significant long-term environmental benefits in terms of sewer service, water quality, and related values, offsetting the other gneally minor and localized adverse impacts which would occur primarily during construction. The adoption of the No Action Alternative would aviod the generally minor, short-term, and mitigatable impacts associated with major construction, but would result in further deterioration of sewer service, water quality, and related values.

INTRODUCTION

Project Background

Purpose of and Need for Action

The Lower Missouri River Basin study area (MSD Northwest) was annexed by the Metropolitan St. Louis Sewer District (MSD) on May 10, 1977 following an areawide election. On January 1, 1978 MSD began operations of the existing wastewater collection and treatment facilities in the basin. Prior to that time, sewer service was provided primarily by the privately owned Fee Fee Trunk Sewer Company. In addition to the Missouri River Wastewater Treatment Plant, now operated by MSD, there are five small privately owned treatment facilities in the area.

The collection facilities in the study area experience problems such as bypasses of raw sewage from illegal bypass structures, overflowing manholes, backups in homes, outages of pump stations and leaking force mains. Sewers which are now undersized due to development in the watersheds, as well as faulty construction of sewers and illegal connections of roof and foundation drains, compound the problem, which threatens human health as well as the natural environment. The collection system includes numerous bypass parts, including at least six upstream of Creve Coeur Lake, resulting in considerable stream and lake pollution. (The locations of 25 known bypasses are shown on Plate 2, described later in this document.)

Furthermore, several small treatment facilities do not accomplish adequate treatment of the wastewater before discharge. During periods of heavy rainfall when wastewater flow to the Missouri River Wastewater Plant is as much as 50 percent more than the design flow, the plant must discharge inadequately treated wastewater, and sometimes raw sewage, directly to Creve Coeur Creek or the Missouri River.

These difficulties with equipment and operations result in the pollution of surface and ground water resources, odor and aesthetic nuisances, and health hazards in the study area and neighboring communities.

Project Area Boundaries

The Lower Missouri River Basin Facility planning area is located in west St. Louis County, extending from 10 to 20 miles west of the city of St. Louis central business district. (See Plate 1.) The study area is generally bounded by the Missouri River and Interstate 70 on the north, the Missouri River and Etherton Road (Missouri Highway 109) on the west, Interstate 270 and Lindbergh Boulevard on the east, and Clayton Road and Olive Street Road on the south. (See Plate 2.)

The study area has been divided into five sections: Fee Fee Creek, Creve Coeur Creek, Caulks Creek, and Bonhomme Creek watersheds and the Missouri River floodplain. Of these areas, Fee Fee, Creve Coeur, and Caulks Creeks are the three major drainage basins. The Caulks Creek watershed has been excluded from this EIS.

201 Facilities Plan and Other Related Documents

In response to the problems discussed and in anticipation of increased problems resulting from future population growth in the study area, MSD has submitted to the United States Environmental Protection Agency (EPA) the 201 Facility Plan - Lower Missouri River Basin Study Area. In the plan MSD proposes the construction of new wastewater collection and treatment facilities to provide adequate treatment for an average wastewater flow of 27 million gallons per day (mgd) expected in the year 2000.

The plan is the first step in an application for 75 percent federal funding of the cost of the project, under Section 201 of U.S. Public Law 92-500, the Federal

LOCATION MAP

Lower Missouri River Basin Study Area

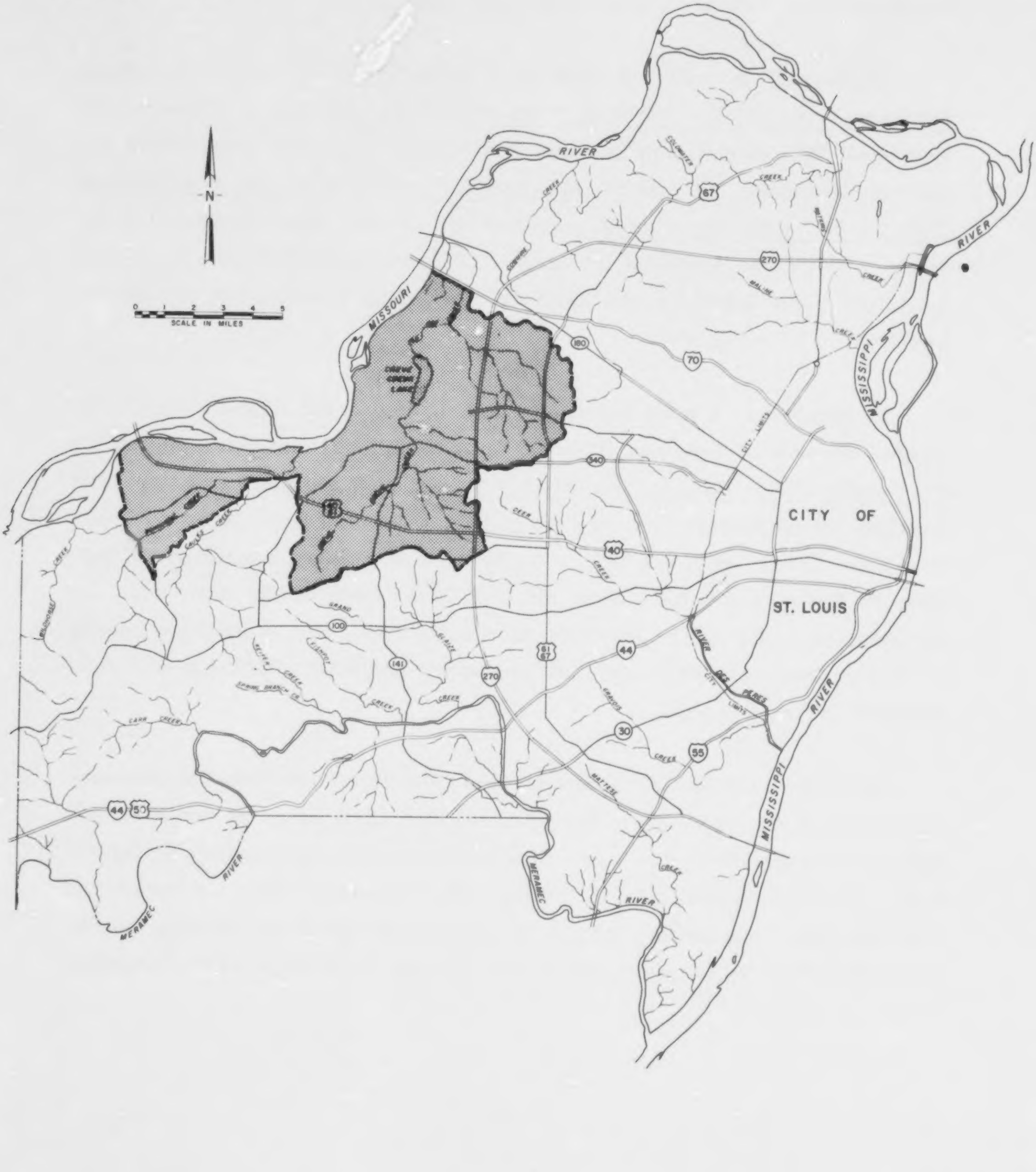
N
0 1 2 3 4 5
SCALE IN MILES
MISSOURI
RIVER
CREEK
67
270
180
70
340
40
100
141
270
61 67
44
30
55
44 50
CITY OF
ST. LOUIS
RIVER DES PERES
CITY LIMITS
MISSISSIPPI
RIVER
MERAMEC
RIVER
GRAND
CREEK
DEER
CREEK
MERAMEC
RIVER

PLATE 1

Water Pollution Control Act. The United States Environmental Protection Agency (USEPA) has prepared this Environmental Impact Statement (EIS) to address the impacts offer the greatest concentration of resource-based recreational opportunities. This is largely due to the national forests, the terrain of the Ozarks, and the area's several large reservoirs.

Earlier reports on the northwest area, primarily the St. Louis County Water Pollution Control Study - Phase II, Areas Tributary to the Missouri River, dated September 1973, prepared by the East-West Gateway Coordinating Council and Zurheide-Herrmann, Inc. and The Areawide Waste Treatment Management Study (208) for St. Louis City/County, prepared by the East-West Gateway Coordinating Council and published in March 1978, have concluded that a regional treatment plant would be the most cost-effective solution for wastewater treatment in the study area.

In response to a more immediate need in the Caulks Creek watershed (a subdrainage area of the Lower Missouri River Basin), MSD has also submited the 201 Facility Plan - Caulks Creek Study Area in which collection and treatment facilities for an average flow of 2.5 mgd have been proposed. Under the plan, the Caulks Creek treatment facility would serve as an interim facility until such time as the plan for the Lower Missouri River Basin Study Area could be implemented. EPA has responded to the Caulks Creek plan by issuing a Finding of No Significant Impact (FONSI) and has authorized MSD to proceed with final design of the facility plan.

Because of particularly severe problems and complaints from the Claymark subdivision in the study area, the EPA initiated early study of the area and subsequently separated this portion from the Environmental Impact Statement (EIS). The EPA has concluded its National Environmental Policy Act review and approved Step I engineering efforts for interceptor sewers to transport wastewater flow from the Claymark area to the Missouri River Wastewater Treatment Plant.

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U.S. Environmental Protection Agency

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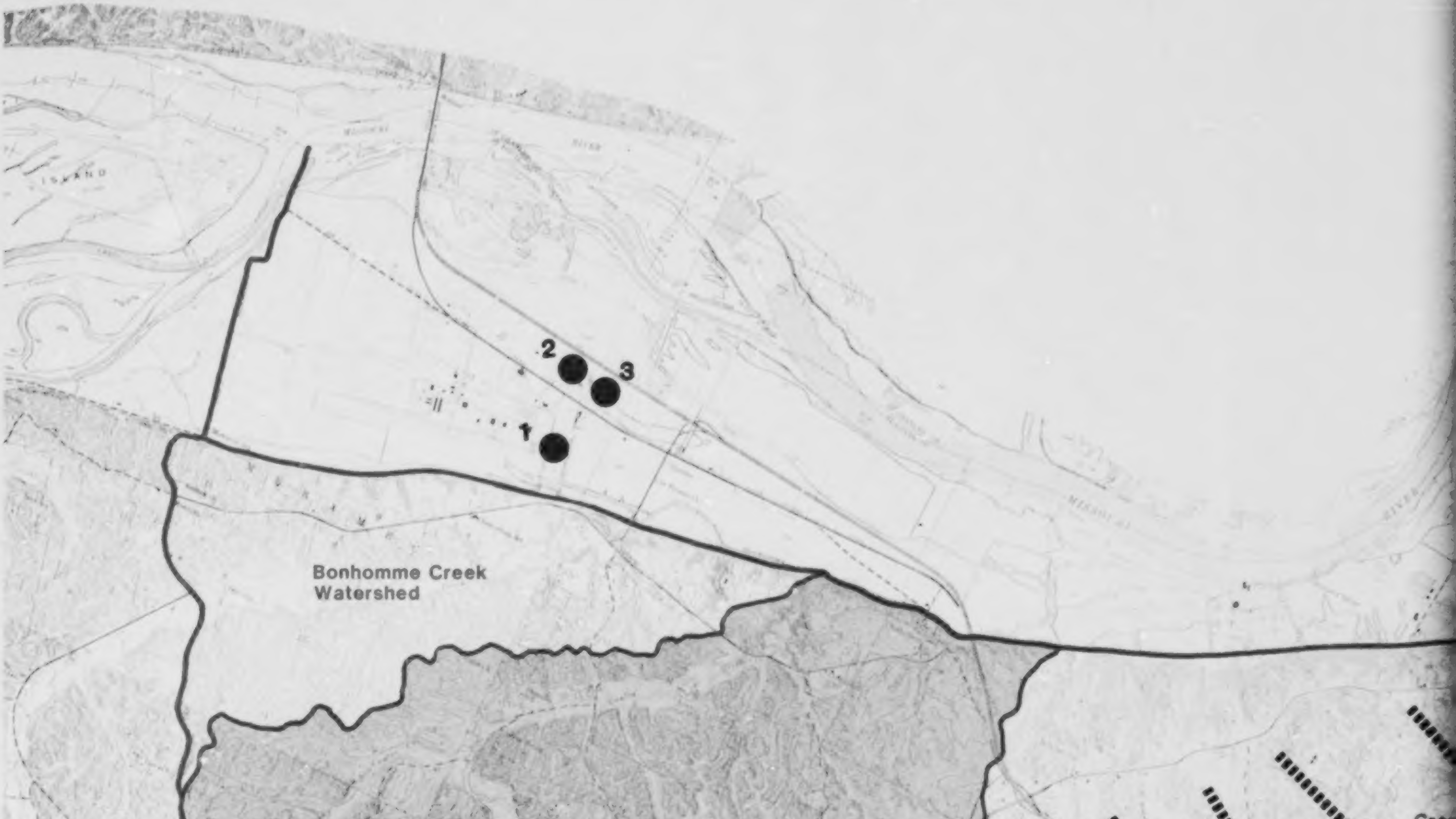
EXISTING FACILITIES


2
3
1
Bonhomme Creek Watershed
Caulks Creek Watershed
(Not included in study area)
A
B
C
D
Cre
Wa

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

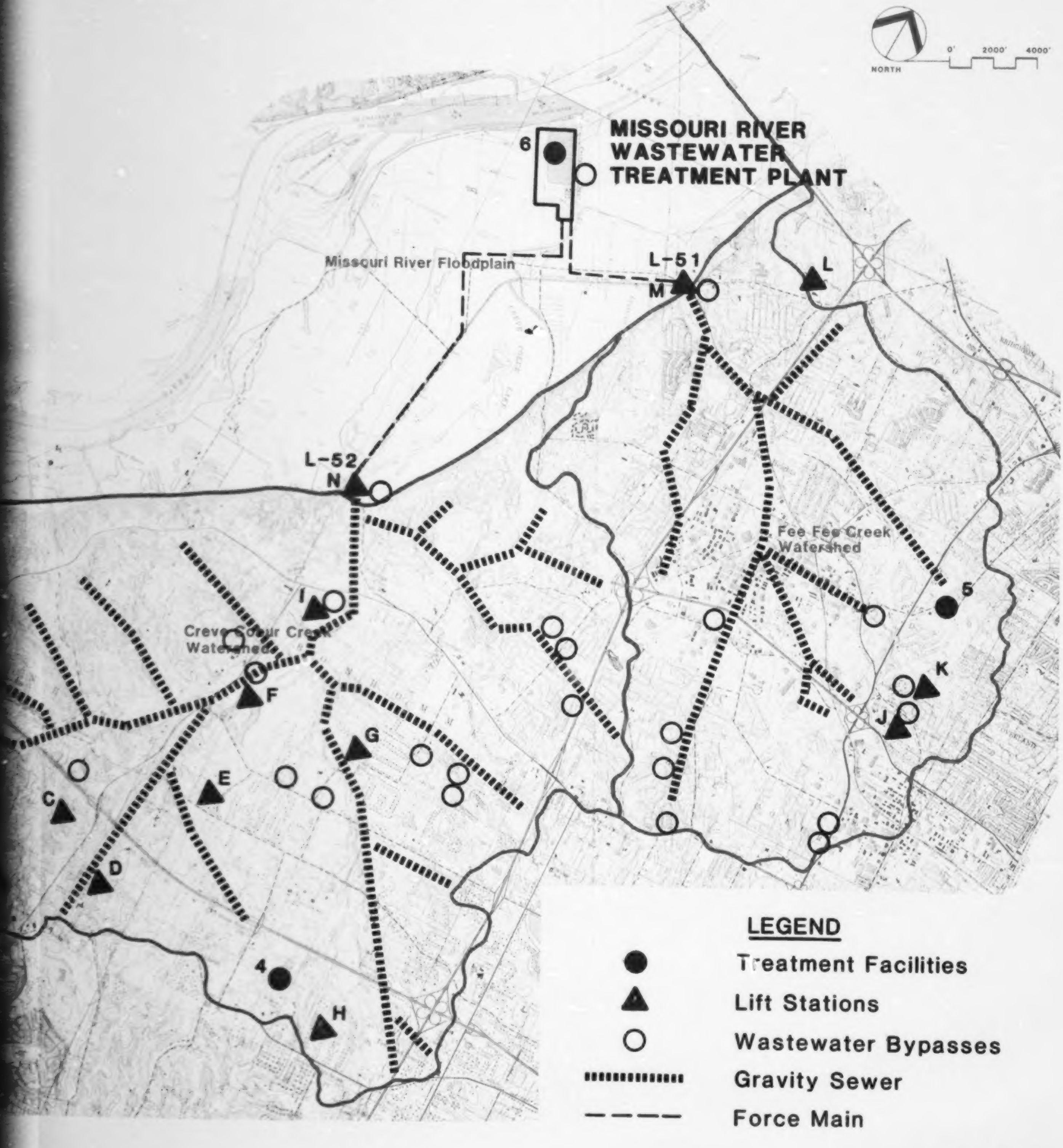

NORTH
0'
2000'
4000'
MISSOURI RIVER WASTEWATER TREATMENT PLANT
6
Missouri River Floodplain
L-51
M
L
L-52
N
Fee Fee Creek Watershed
Creve Coeur Creek Watershed
I
F
G
E
C
D
4
H
5
K
J
LEGEND
● Treatment Facilities
▲ Lift Stations
○ Wastewater Bypasses
Gravity Sewer
Force Main

PLATE 2

Wastewater Management Alternatives

For comparison to the MSD's Proposed Action, the environmental impacts of two alternatives have been evaluated. The three possible courses of action are summarized below.

No Action Alternative

The No Action Alternative includes no major upgrading of existing facilities, nor construction of new facilities. Routine maintenance of the existing wastewater collection and treatment system would be performed to facilitate its operation.

Proposed Action Alternative

The MSD's Proposed Action Alternative is a regional wastewater management approach which involves upgrading existing collection facilities, and constructing new collection and treatment facilities in order to increase capacity and improve treatment efficiency. Plate 3 illustrates the Proposed Action Alternative.

Collection Facilities. Eight pump stations in the Fee Fee Creek and Creve Coeur Creek watersheds, which currently pump wastewater through force mains to treatment facilities, would be eliminated. The force mains would be replaced with gravity sewers to transport the wastewater via interceptor sewers to the Missouri River Wastewater Treatment Plant. The capacities of six existing pump stations would be increased. Two of these, lift stations L-51 and L-52, collect all wastewater from the Fee Fee Creek and Creve Coeur Creek watersheds respectively, and pump it to the treatment plant. Station L-51, which currently houses two 7,000 gallon per minute (gpm) pumps would be rebuilt to house three 8,000 gpm pumps. The capacity would be 23 million gallons per day (mgd), based on using two pumps, the third serving as a backup unit. Station L-52 would be rebuilt to replace its three 7,000 gpm pumps with three 10,000 gpm units, resulting in a capacity of 29 mgd with two pumps operating. In accordance with these new pumping capacity increases, a new 30-inch diameter force main would be laid parallel to the existing 24-inch line from L-51 to the treatment plant, and the existing 36-inch force main from station L-52 would be replaced with a 42-inch pipe.

In addition, a new pump station would be built in the floodplain to transport wastewater from existing treatment facilities at Artronix, the St. Louis County Correctional Institute, and the Spirit West Air Park (via a Caulks Creek pump station) to the Missouri River Wastewater Treatment Plant. The floodplain wastewater collection system would also include new gravity sewers leading to the new pump station and a new 10-inch force main between the new pump station and the Caulks Creek pump station. New gravity sewers from existing treatment facilities at the Four Star Motel and Principia School would be connected to Fee Fee Creek and Creve Coeur Creek interceptor sewers, eliminating discharge from these sources to the respective creeks.

A 27-inch force main would be constructed in the floodplain to carry wastewater to station L-52 from the Caulks Creek interim wastewater treatment plant (currently in the final design stage under the Caulks Creek 201 Facilities Plan). The Caulks Creek watershed wastewater flow which is expected to average about 3 mgd in the year 2000, along with the flow from the three floodplain facilities would be diverted to the Missouri River Wastewater Treatment Plant.

The 201 Facilities Plan for the Bonfils Area includes facilities to collect wastewater from the Bonfils area (located directly north of the Fee Fee Creek watershed) and pump it to the Missouri River Wastewater Treatment Plant. Design and construction of the collection and pumping facilities for the Bonfils area are not included in the 201 plan for the Lower Missouri River Basin study area, but execution of the plan will have impact on the area.

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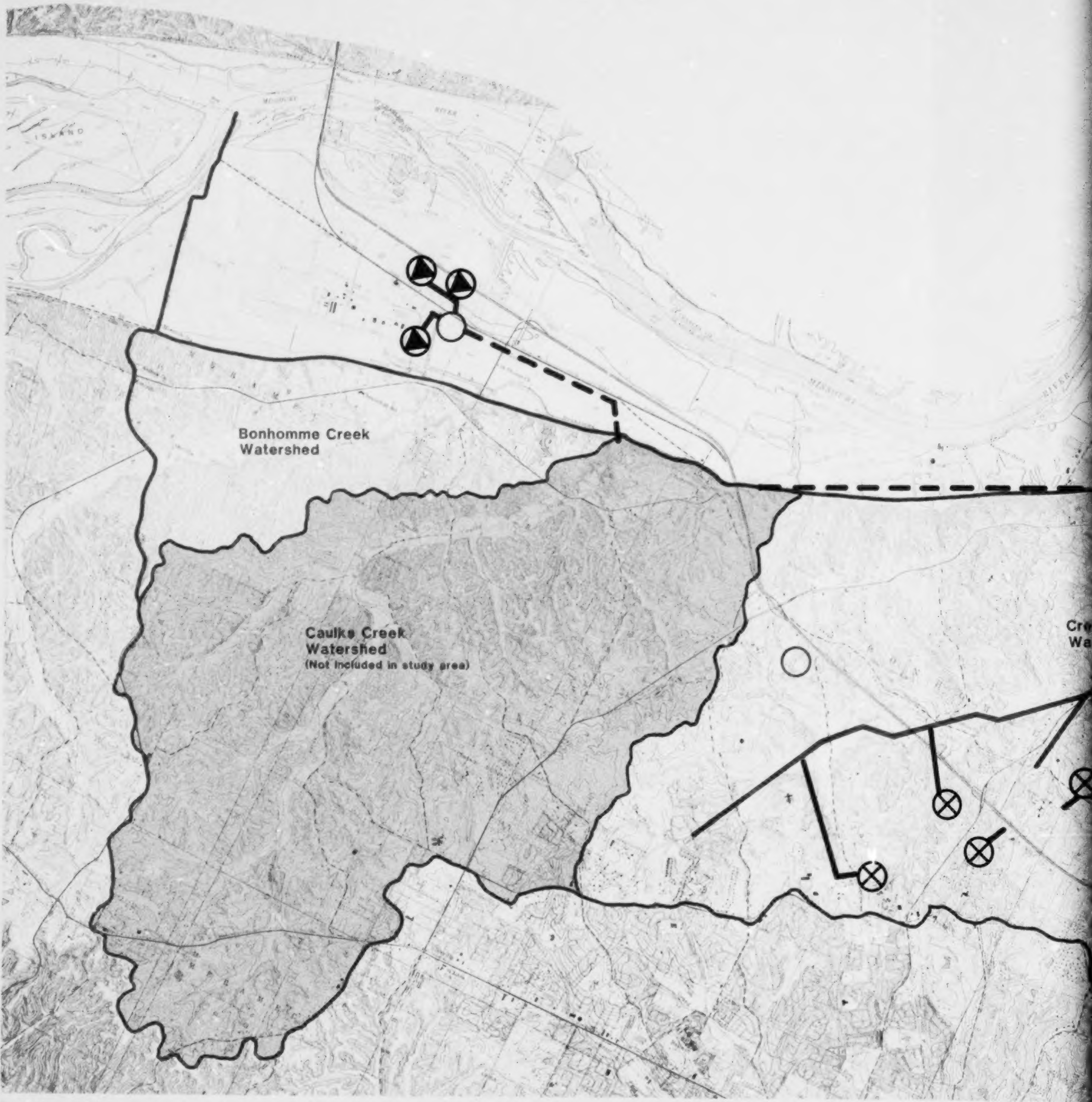
PROPOSED ACTION


Bonhomme Creek
Watershed
Caulks Creek
Watershed
(Not included in study area)
Cr
Wa

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

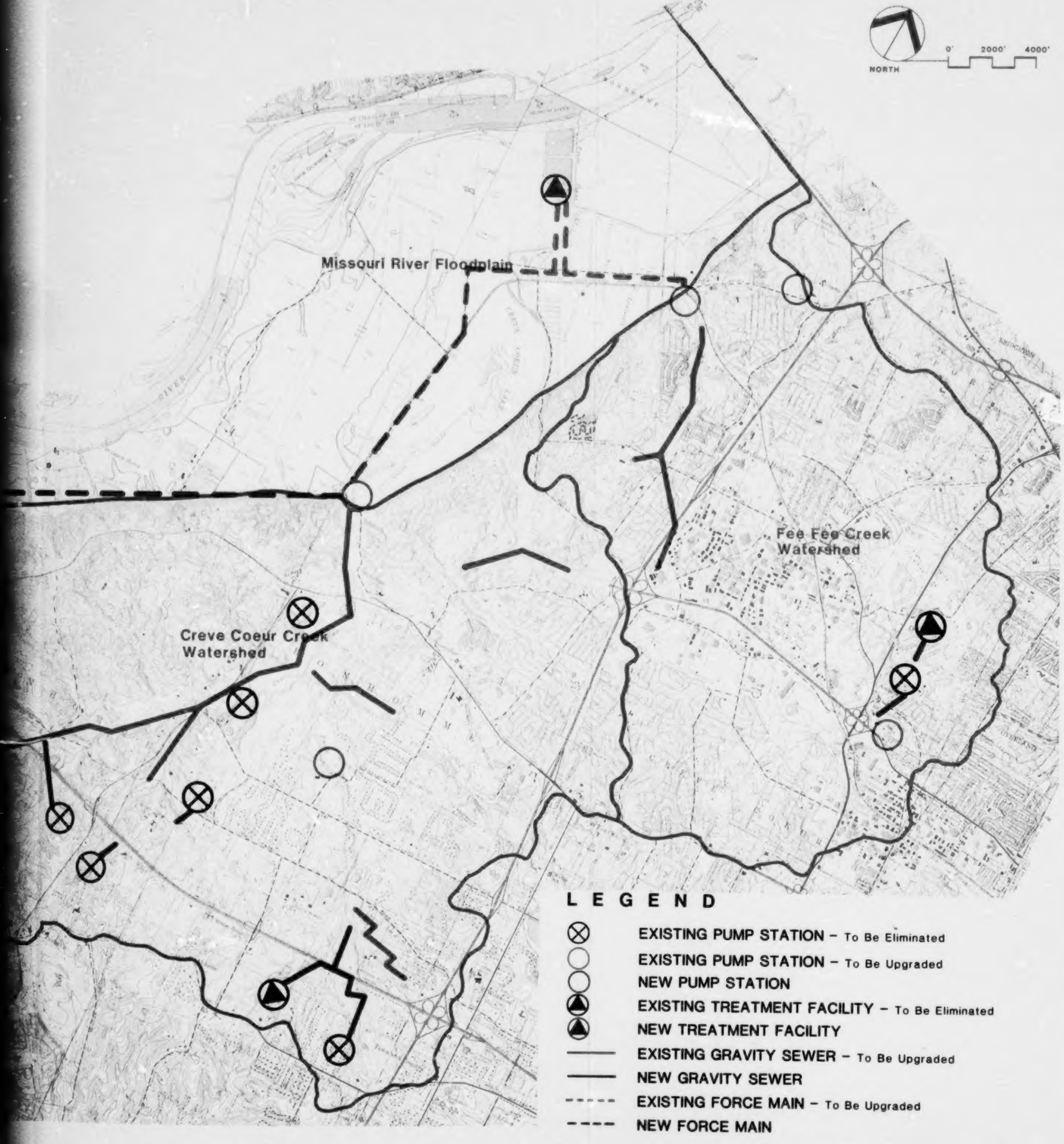

NORTH
0'
2000'
4000'
Missouri River Floodplain
Fee Fee Creek Watershed
Creve Coeur Creek Watershed
LEGEND
EXISTING PUMP STATION - To Be Eliminated
EXISTING PUMP STATION - To Be Upgraded
NEW PUMP STATION
EXISTING TREATMENT FACILITY - To Be Eliminated
NEW TREATMENT FACILITY
EXISTING GRAVITY SEWER - To Be Upgraded
NEW GRAVITY SEWER
EXISTING FORCE MAIN - To Be Upgraded
NEW FORCE MAIN

PLATE 3

Treatment Facility. A new 27 mgd wastewater treatment facility would be constructed adjacent to the site of the existing Missouri River Treatment Plant. The existing treatment facilities, with the exception of the sludge lagoons, would be abandoned after construction of the new plant.

The proposed treatment plant would consist of equipment for flow metering, screening, grit removal, sedimentation, conventional stepwise aeration, clarification of the mixed liquor, sludge thickening by dissolved air flotation, and sludge stabilization by anaerobic digestion. Effluent from the treatment facility would be pumped to the Missouri River. In addition to the construction of the treatment facilities, the flood protection levee which surrounds the existing plant would be extended to enclose an additional 21 acres.

Summary. In total, wastewater collection system improvements would include the replacement of about 18 miles of gravity sewers and force mains and the addition of about 13 miles of new lines. Eight pump stations and five small treatment facilities would be eliminated, while six pump stations would be upgraded and one would be added. The Missouri River Wastewater Treatment Plant would be rebuilt to provide primary and secondary treatment to an average wastewater flow of 27 mgd.

Subregional Alternative

The Subregional Alternative, developed conceptually for the purposes of this Environmental Impact Statement, is not as well defined as the Proposed Action, for which a detailed Facilities Plan had been prepared. However, the reader should be cautioned that, insofar as allowed by the available information, the intent of this document is to present a balanced evaluation of all of the alternatives.

Collection Facilities. The Subregional Alternative includes separate wastewater collection and treatment facilities for two areas: the Caulks Creek watershed and Creve Coeur Creek/Bonfils area. Plate 4 illustrates the Subregional Alternative.

As in the Proposed Action, eight pump stations and five small treatment facilities would be eliminated by the construction of new sewers, six pump stations would be upgraded, and one new pump station would be built.

Because two separate treatment facilities would be operated under this alternative, the force main crossing the floodplain from the Caulks Creek Wastewater Treatment Plant to lift station L-52 would not be constructed. The lift station would be upgraded, but smaller pumps would be installed than in the case of the Proposed Action, and the 36-inch force main to the treatment plant would be replaced but not increased in size. (The force main from the Bonfils area to the Missouri River Treatment Plant would be constructed under the Bonfils area facilities plan.)

Other aspects of the wastewater collection and transmission system would be the same as in the Proposed Action.

Treatment Facilities. The Missouri River Treatment Plant would be upgraded and expanded to allow sufficient treatment of an average flow of 20 mgd, a 100 percent increase over the design flow of the existing facilities. The upgrading would include mechanical equipment replacement and the addition of primary clarification and fine bubble aerator. The expansion would be accomplished by the addition of contact stabilization equipment similar to that at the existing plant. Effluent would be discharged to Creve Coeur Creek. The existing levee would be extended to encompass about six more acres in order to protect the additional equipment.

The Caulks Creek Treatment Plant would become a permanent, rather than interim, facility. Modifications to the plant's ongoing design would be necessary to increase its design flow from 2.5 to 3 mgd, in order to handle expected growth in flow between 1990 and the year 2000.

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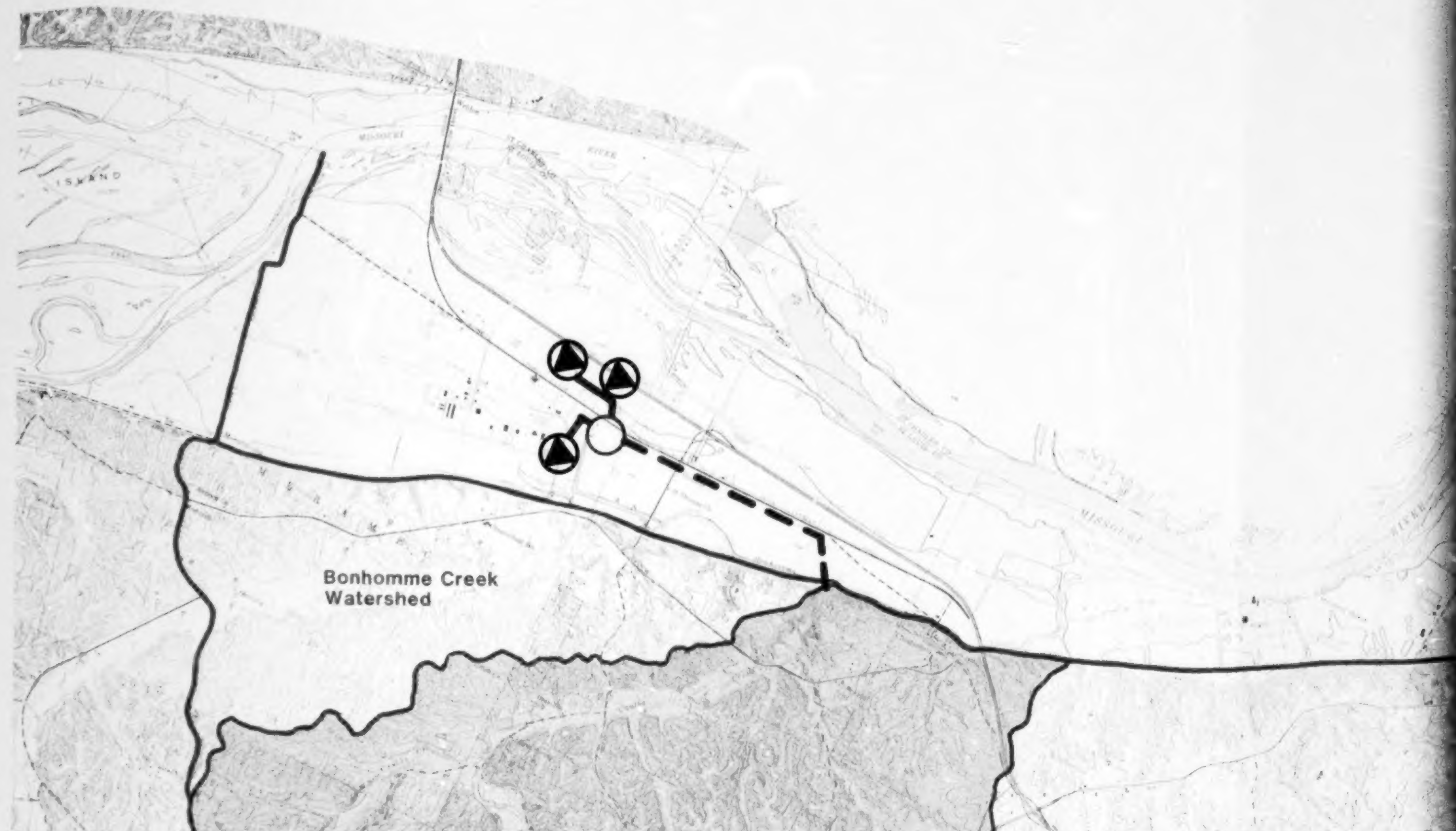
SUB-REGIONAL ALTERNATIVE


ISLAND
MISSOURI
RIVER
Bonhomme Creek
Watershed
Caulks Creek
Watershed
(Not included in study area)
Cre
Wa

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

NATIVE

Lower Missouri River Basin Study Area

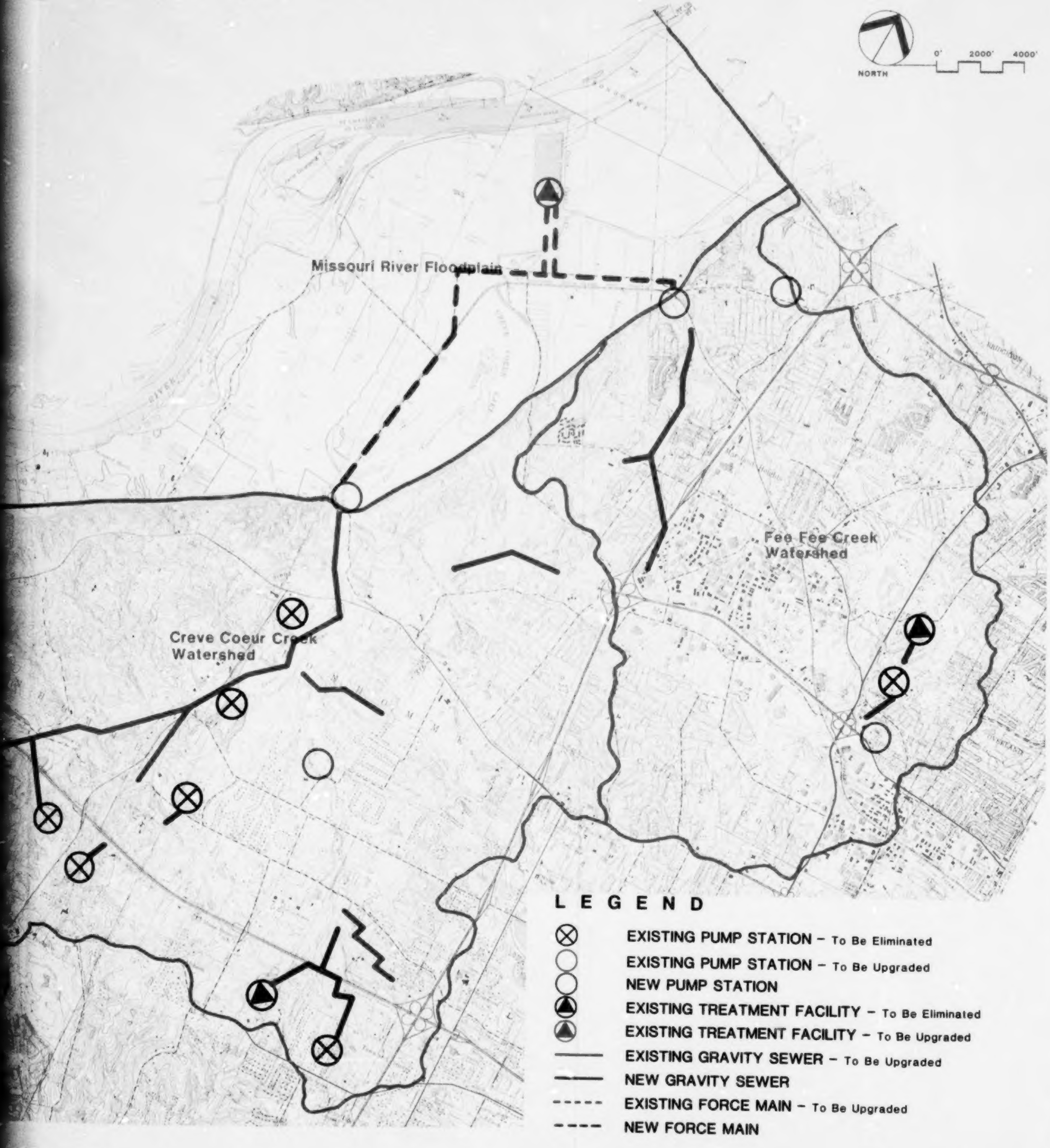

NORTH
0'
2000'
4000'
Missouri River Floodplain
Fee Fee Creek Watershed
Creve Coeur Creek Watershed
LEGEND
⊗ EXISTING PUMP STATION - To Be Eliminated
○ EXISTING PUMP STATION - To Be Upgraded
○ NEW PUMP STATION
▲ EXISTING TREATMENT FACILITY - To Be Eliminated
▲ EXISTING TREATMENT FACILITY - To Be Upgraded
EXISTING GRAVITY SEWER - To Be Upgraded
NEW GRAVITY SEWER
EXISTING FORCE MAIN - To Be Upgraded
NEW FORCE MAIN

PLATE 4

Summary. Wastewater collection system improvements would be similar to those in the Proposed Action, except that the floodplain force main from the Caulks Creek Wastewater Treatment Plant to lift station would not be built. The Missouri River Wastewater Treatment Plant would be upgraded and expanded to treat an average daily flow of about 20 mgd.

EXISTING CONDITIONS

Natural Environment

Physiography

The study area is located in north and west-central St. Louis County, within the Dissected Till Plain Physiographic Section and near the northeast boundary of the Ozark Plateau Physiographic Province. Topographic relief in the area ranges from about 440 feet above mean sea level (msl) near the Missouri River to 720 feet above msl in the southeastern uplands. The Missouri River floodplain is nearly flat and is bounded by a steep bluff line with slopes of over 30 percent in some localized sections. The major portion of the study area is characterized by gently rolling uplands.

Geology

The periods of geologic formations exposed in the study area range in age from Ordovician to middle Pennsylvanian. (See Appendix Table A-1 and Plate 5.) Shales dating from the upper Ordovician period are exposed in the southern and southwestern parts of St. Louis County, and rocks of the Mississippian period are exposed along the bluff line adjacent to the Missouri River floodplain. Pennsylvanian rocks which overlie Mississippian rock consist of sandstone, clay, shales, and limestone and occur primarily in the northern uplands of the study area. Pennsylvanian deposits are overlain by more recent Cenezoic deposits which include Pliocene gravel deposits; Pleistocene glacial, alluvial (stream-deposited), and aeolian (wind-deposited) deposits; and recent alluvium. In areas underlain by limestone, minor karst features and sinkholes have developed. The surface has also been modified in some places by mining and quarrying.

Bedrock structure in the St. Louis area is relatively flat, with a slight regional dip towards the northeast. This dip has been modified by several minor northwest-southeast trending faults within the area. Recent faulting has not been identified in the field or in a review of the published literature. The study area, however, is located in a seismic risk zone where moderate damage could occur from a seismic event. The historical record indicates that seismic events have occurred in the vicinity of St. Louis which have been capable of at least minor damage in the area.

Soils

The major soil deposits in the study area are modified loess, which is homogenous soil derived from glacial deposits, and alluvium. Alluvium along the Missouri River floodplain consists of gravel, sands, silts, and clays often more than 100 feet in thickness. These deposits are overlain by more recent floodplain deposits of clay and silts. Thin alluvial deposits are also present along the tributary streams. Alluvial terraces, which formed during the Pleistocene when the Missouri River was flowing at a higher elevation, occur above the present floodplain.

Most of the upland area is blanketed by loess. This loess is thickest along the bluffs and ridge tops adjacent to the Missouri River floodplain and tends to thin out towards the east. The deposits are generally 40 to 80 feet thick along the bluff line and consist of a silt-rich loess underlain by a clay-rich loess. A transition zone between the loess and bedrock generally occurs, which consists of loess, residual clays, and decomposed bedrock.

The engineering properties of near-surface materials in the study area are dependent on the properties of the soils and rock, and the location relative to topography and groundwater levels. In addition, stability of surface materials is, in some cases, dependent on the degree of solution action affecting underlying limestones. Plate 6 describes the location and engineering properties of soils in the study area.

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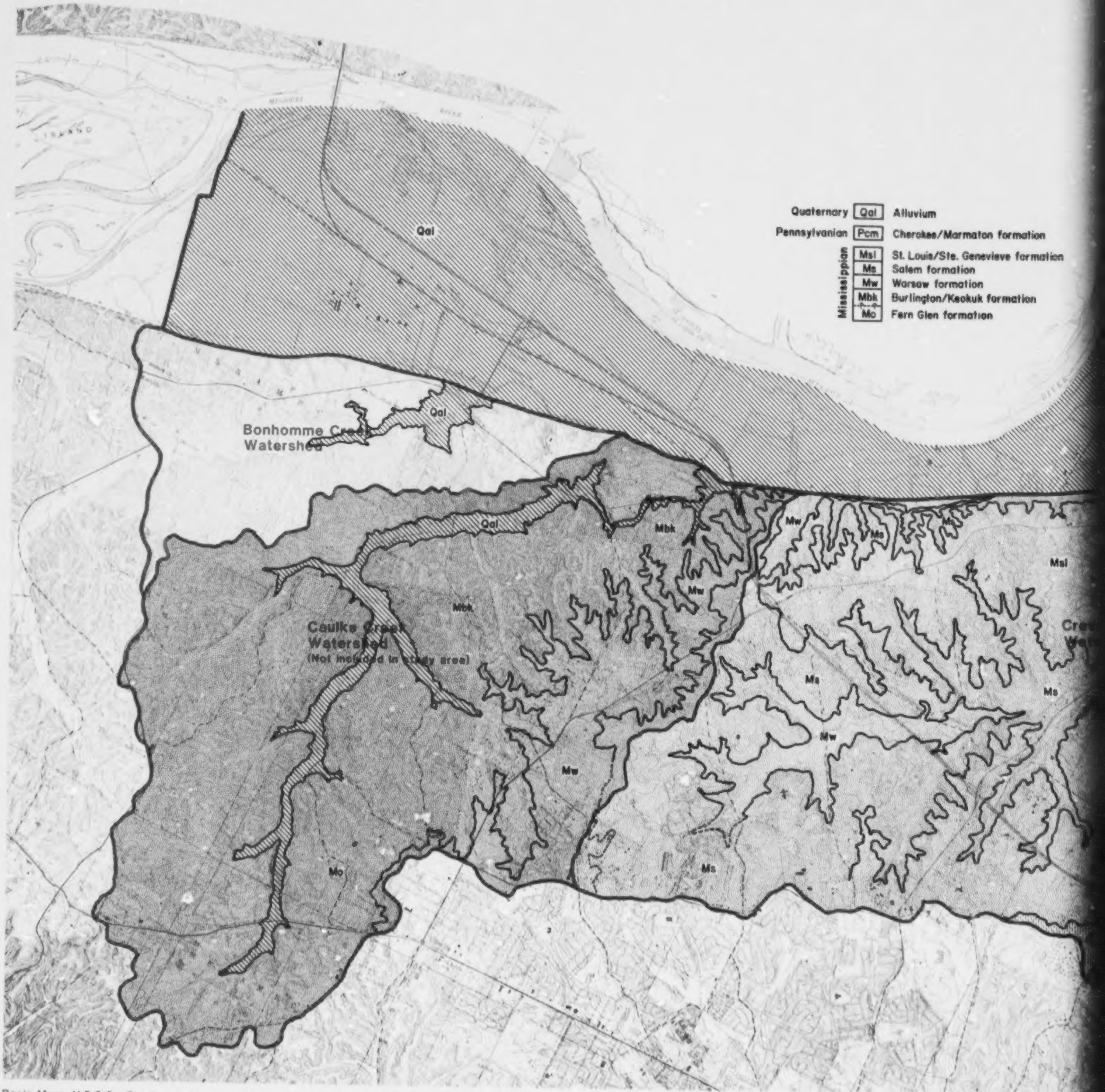
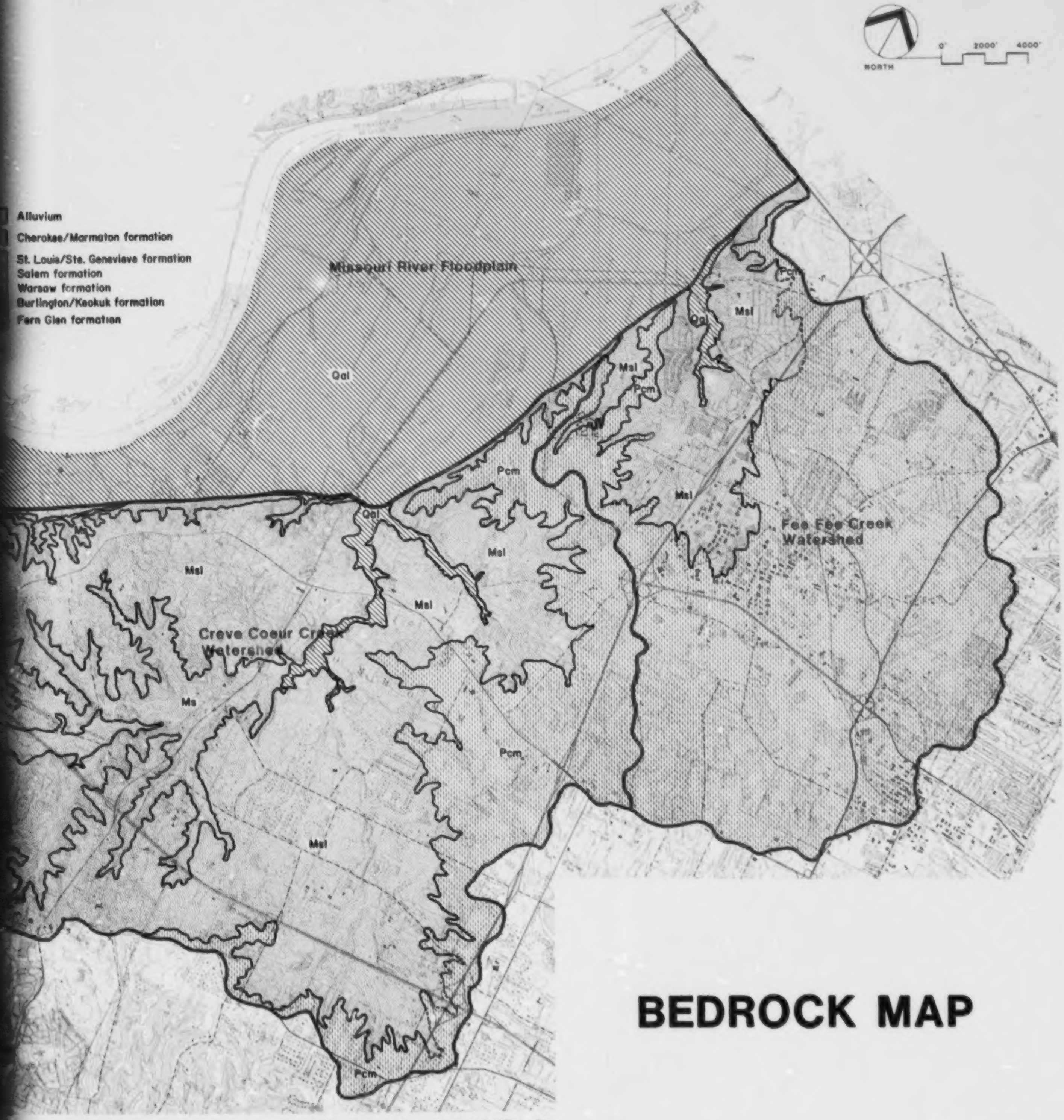

Quaternary Qal Alluvium
Pennsylvanian Pcm Cherokee/Marmaton formation
Mississippian
Msl St. Louis/Ste. Genevieve formation
Ms Salem formation
Mw Warsaw formation
Mbk Burlington/Keokuk formation
Mo Fern Glen formation
Qal
Bonhomme Creek Watershed
Caulks Creek Watershed
(Not included in study area)
Mbk
Mw
Ms
Msl
Mo

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area


Alluvium
Cherokee/Marmaton formation
St. Louis/Ste. Genevieve formation
Salem formation
Warsaw formation
Burlington/Keokuk formation
Fern Glen formation
NORTH
0'
2000'
4000'
Missouri River Floodplain
Qal
Msl
Pcm
Ms
Creve Coeur Creek Watershed
Fee Fee Creek Watershed

BEDROCK MAP

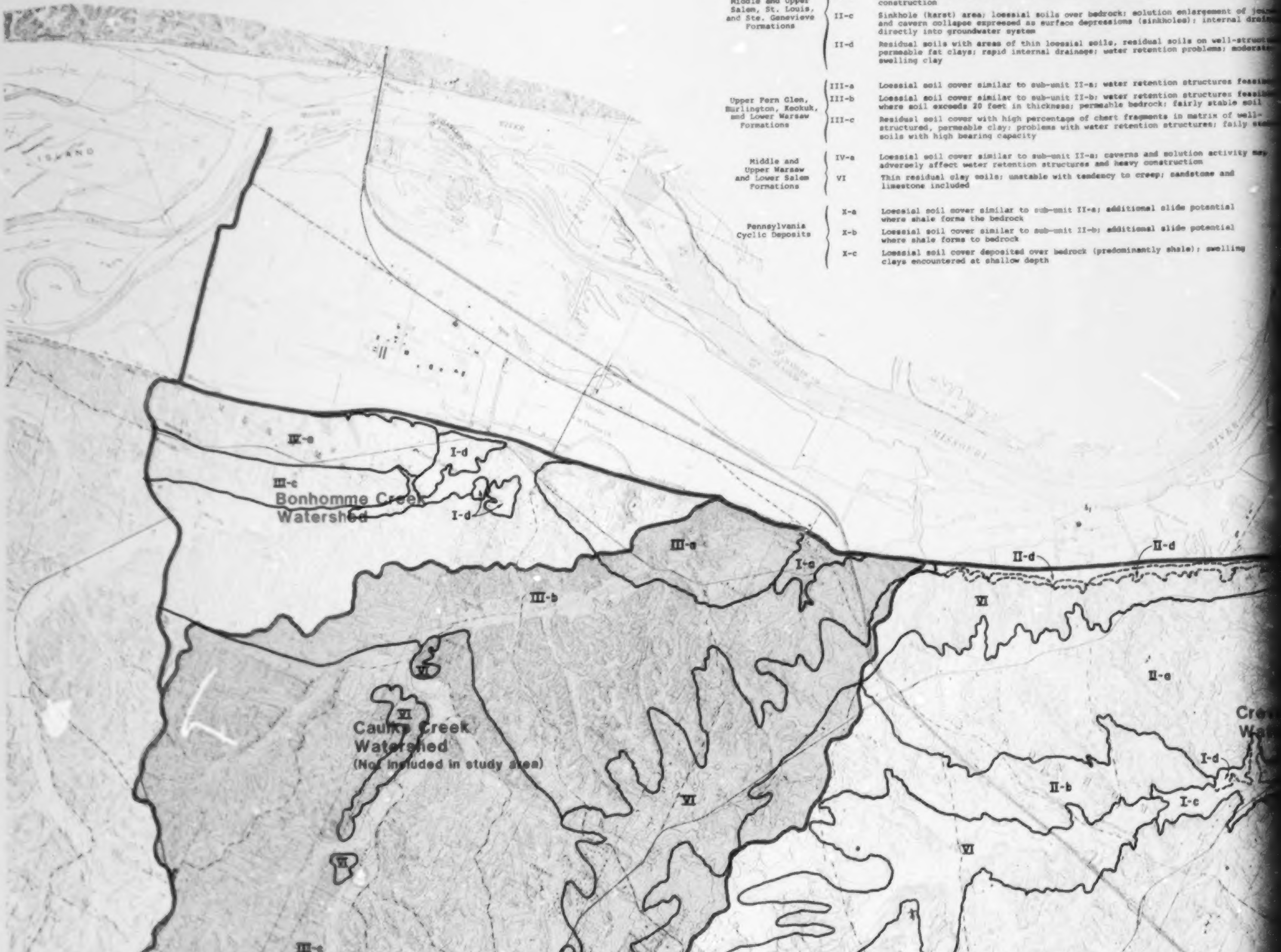
Map Prepared by: Shannon & Wilson, Inc.

PLATE 5

Prepared for
U.S. Environmental Protection Agency

Prepared by
Harland Bartholomew & Associates, Inc.

	Map Symbol	Soil Description
Alluvial Deposits	I-a	Thick alluvium with stratified sands, gravels, silts, and clays; high water tab subject to flooding
	I-c	Lake (lacustrine) deposits; stratified silts and clays; some organic material, somewhat compressible soils, drainage problems
	I-d	Alluvial terraces; stratified sands, silts, and clays; above level of present fl plain
Middle and Upper Salem, St. Louis, and Ste. Genevieve Formations	II-a	Two layers of loess deposited over bedrock; upper layer silt-rich, will suppo slopes; lower layer is clay-rich, natural moisture approaches liquid limit at l interface forming potential slide plane
	II-b	Two layers of loessial soil over bedrock; upper layer thin, has little effect construction
	II-c	Sinkhole (karst) area; loessial soils over bedrock; solution enlargement of jo and cavern collapse expressed as surface depressions (sinkholes); internal drai directly into groundwater system
	II-d	Residual soils with areas of thin loessial soils, residual soils on well-struct permeable fat clays; rapid internal drainage; water retention problems; moderat swelling clay
Upper Fern Glen, Burlington, Keokuk, and Lower Warsaw Formations	III-a	Loessial soil cover similar to sub-unit II-a; water retention structures feasi
	III-b	Loessial soil cover similar to sub-unit II-b; water retention structures feasi where soil exceeds 20 feet in thickness; permeable bedrock; fairly stable soil
	III-c	Residual soil cover with high percentage of chert fragments in matrix of well-structured, permeable clay; problems with water retention structures; faily st soils with high bearing capacity
Middle and Upper Warsaw and Lower Salem Formations	IV-a	Loessial soil cover similar to sub-unit II-a; caverns and solution activity ma adversely affect water retention structures and heavy construction
	VI	Thin residual clay soils; unstable with tendency to creep; sandstone and limestone included
Pennsylvania Cyclic Deposits	X-a	Loessial soil cover similar to sub-unit II-a; additional slide potential where shale forms the bedrock
	X-b	Loessial soil cover similar to sub-unit II-b; additional slide potential where shale forms to bedrock
	X-c	Loessial soil cover deposited over bedrock (predominantly shale); swelling clays encountered at shallow depth



Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Soil Description

sands, gravels, silts, and clays; high water table.

ntified silts and clays; some organic material,
drainage problems

sands, silts, and clays; above level of present flood

over bedrock; upper layer silt-rich, will support 90°
h, natural moisture approaches liquid limit at loess
lide plane

r bedrock; upper layer thin, has little effect on

l soils over bedrock; solution enlargement of joints
s surface depressions (sinkholes); internal drainage

hin loessial soils, residual soils on well-structured,
rnal drainage; water retention problems; moderate

sub-unit II-a; water retention structures feasible

sub-unit II-b; water retention structures feasible
thickness; permeable bedrock; fairly stable soil

percentage of chert fragments in matrix of well-
blems with water retention structures; faily stable
ty

sub-unit II-a; caverns and solution activity may
n structures and heavy construction

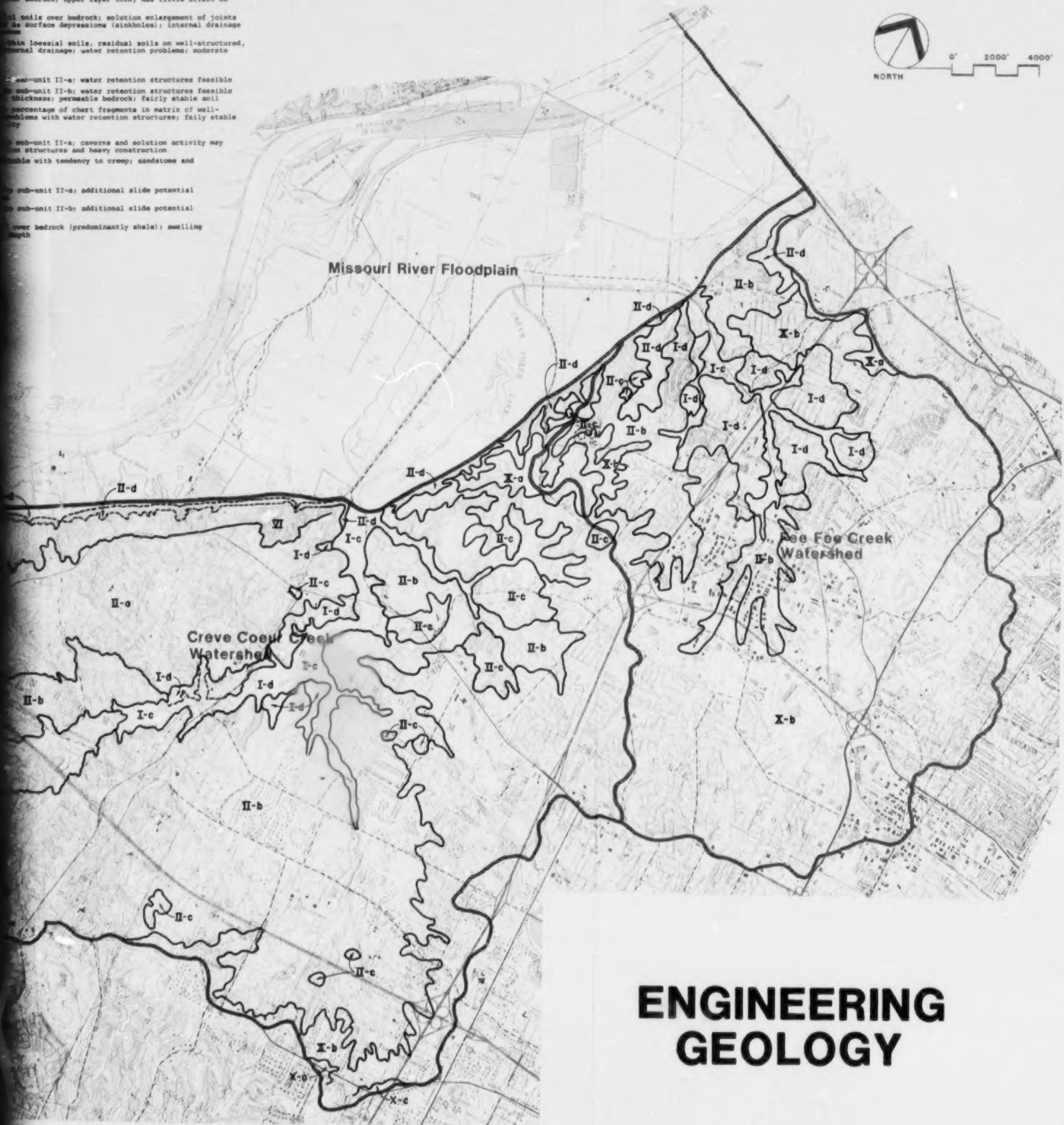
ble with tendency to creep; sandstone and

sub-unit II-a; additional slide potential

sub-unit II-b; additional slide potential

over bedrock (predominantly shale); swelling
depth

Lower Missouri River Basin Study Area


NORTH
0'
2000'
4000'
Missouri River Floodplain
Creve Coeur Creek Watershed
Fee Fee Creek Watershed
II-d
II-b
X-b
X-c
I-d
I-c
II-c
II-a
VI
X-a
II-a

Map Prepared by: Shannon & Wilson, Inc.

ENGINEERING GEOLOGY

PLATE 6

Prime Agricultural Land. Soils with properties which are best suited for the production of food, feed, forage, fiber, and seed crops are considered to be prime agricultural land. Criteria involving water supply, soil temperature, pH levels, and flooding and erosion hazards have been developed by the U.S. Department of Agriculture. Soils in the study area which meet these criteria are located primarily along the stream channels and in the floodplain of the Missouri River. The predominant crops grown on this land include corn and soybeans.

Hydrology

Surface Water. Subdrainage basin systems in the study area consist of upland watersheds and the Missouri River floodplain. Upland watersheds, which include Fee Fee, Creve Coeur, and Bonhomme Creeks, originate east and southeast of the study area in gently rolling areas which are underlain by clay-rich soils and have slopes generally less than ten percent. As these streams flow towards the Missouri River, the slopes tend to increase, especially at the bluff line. Because of the slopes and the presence of clay-poor soils which occur near the bluff line, severe erosional features are common. Slopes are sharply reduced along the Missouri River floodplain and flows during storm events are reduced in speed, resulting in deposition of suspended materials on the floodplain.

Creve Coeur Creek drains approximately 18,600 acres and is the largest watershed in the study area. Fee Fee Creek, which drains 10,700 acres, is a tributary to Creve Coeur Creek. The confluence of the two creeks occurs in the Missouri River floodplain, downstream of Creve Coeur Lake and approximately one-half mile southeast of the Missouri River Treatment Plant. Caulks Creek is a tributary of Bonhomme Creek, which drains approximately 3,300 acres of additional land in the western portion of the study area.

Upland watersheds in the study area are subject to local flooding during periods of heavy rainfall and in the lower reaches, to a limited extent, from backwater during high stages of the Missouri River. Flooding in the upstream reaches tends to be of the flash flood variety where inundation is rapid and of relatively short duration. Damage is often the result of the severe erosion that may accompany these events. Plate 7 presents the limits of the 100-year floodplain in the study area as determined by the U.S. Army Corps of Engineers. Flood protection levees are present in the Missouri River floodplain, providing protection to portions of the study area including the existing Missouri River Treatment Plant.

Groundwater. Groundwater in the study area is present in alluvial aquifers in the floodplain of the Missouri River and its lower tributaries, the bedrock aquifer, and the perched water tables that occur above the bedrock water table. The most important aquifer in the study area is the alluvial aquifer in the Missouri River floodplain. This aquifer is recharged by vertical infiltration, upstream and upland flows, and to a limited extent, by the bedrock aquifer. In the St. Louis area, the alluvial aquifers, in combination with their associated streams, provide the majority of potable water.

Water Quality and Aquatic Resources

Surface water resources in the study area include the Missouri River, Fee Fee Creek, Creve Coeur Creek, Bonhomme Creek, Creve Coeur Lake and several small lakes and ponds. (See Plate 8.) All three creeks (Fee Fee, Creve Coeur, and Bonhomme) are relatively small, but do contain permanent water in their lower reaches which may be capable of supporting a light sport fishery including species such as bullhead and green sunfish. Other species found in certain portions of these creeks include river carpsucker, stoneroller, mosquito fish, emerald, red and sand shiners, and blunt-nosed minnows.

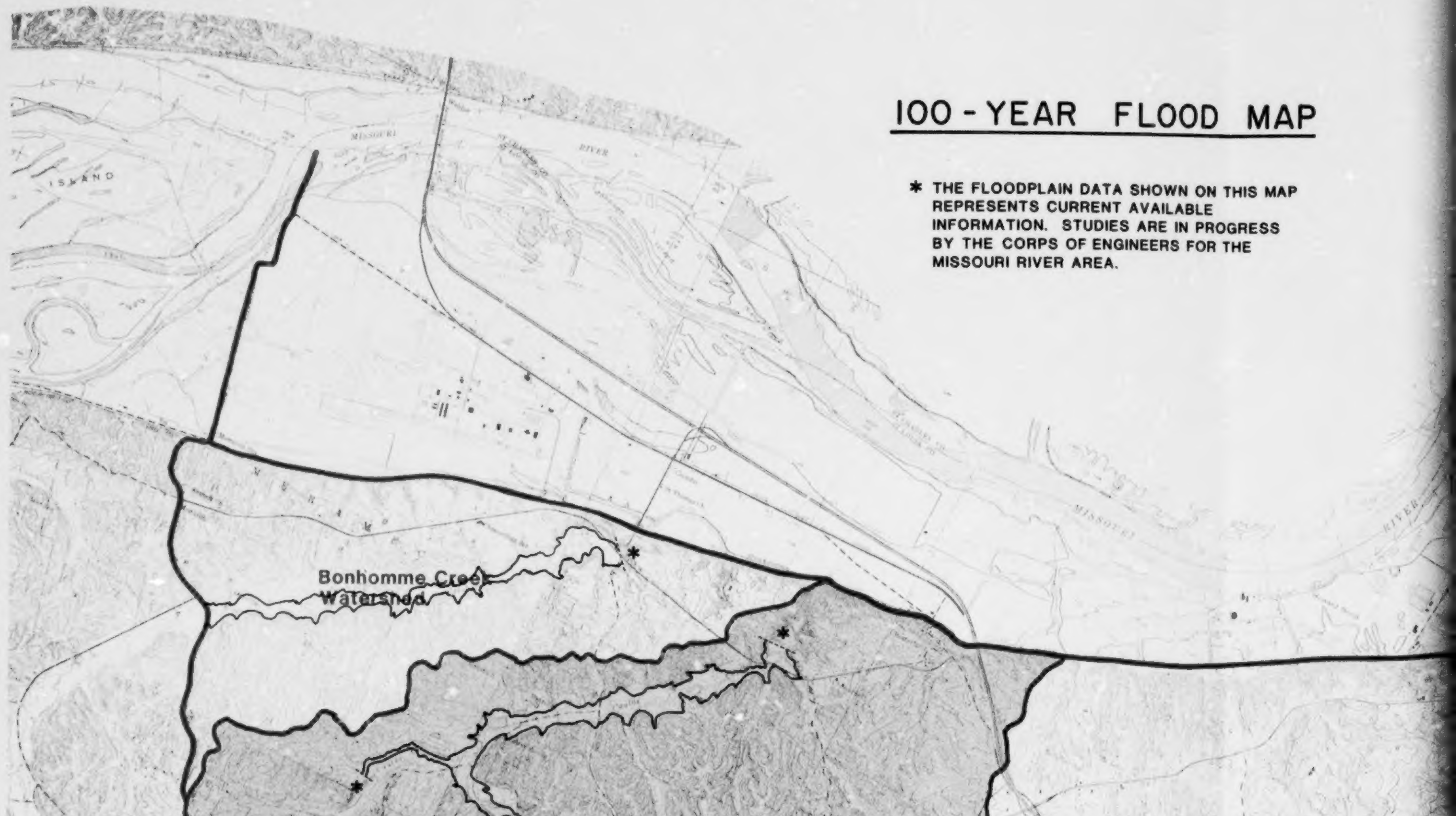
Two reports, the Water Quality Management Plan (1979) and the Water Quality Management Basin Plan for the Lower Missouri River Basin (1976), identify water quality problems in the study area. Such problems are indicated when water quality analyses are not found to be in conformance with applicable standards. (See Table 1.)

Prepared for
U.S. Environmental Protection Agency

Prepared by
Harland Bartholomew & Associates, Inc.

100 - YEAR FLOOD MAP

* THE FLOODPLAIN DATA SHOWN ON THIS MAP REPRESENTS CURRENT AVAILABLE INFORMATION. STUDIES ARE IN PROGRESS BY THE CORPS OF ENGINEERS FOR THE MISSOURI RIVER AREA.


ISLAND
MISSOURI
RIVER
MISSOURI
RIVER
Bonhomme Creek
Watershed
Caulks Creek
Watershed
(Not included in study area)
Cre
Wa

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

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ON THIS MAP
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N PROGRESS
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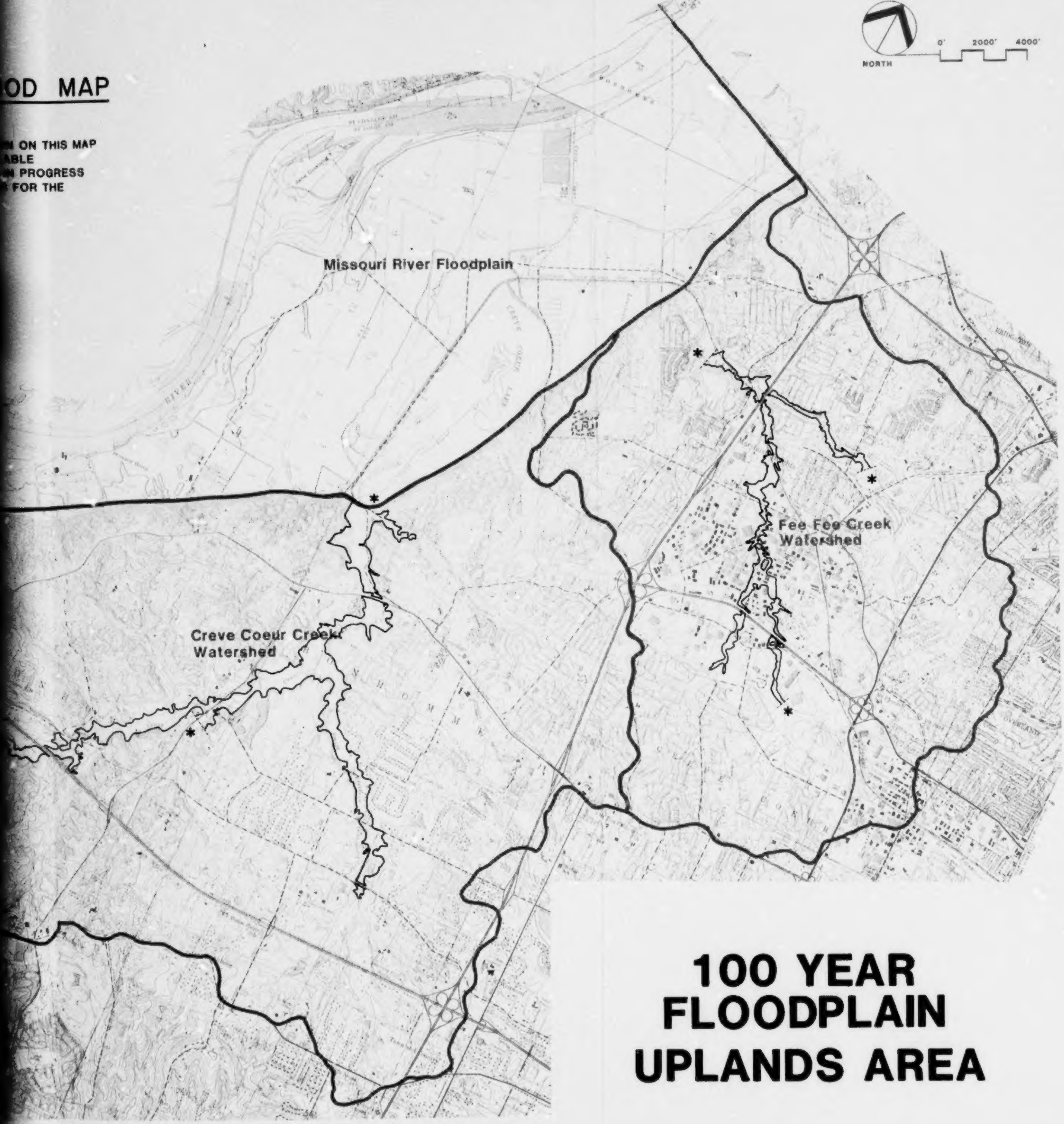

NORTH
0'
2000'
4000'
Missouri River Floodplain
Creve Coeur Creek Watershed
Fee Fee Creek Watershed

100 YEAR FLOODPLAIN UPLANDS AREA

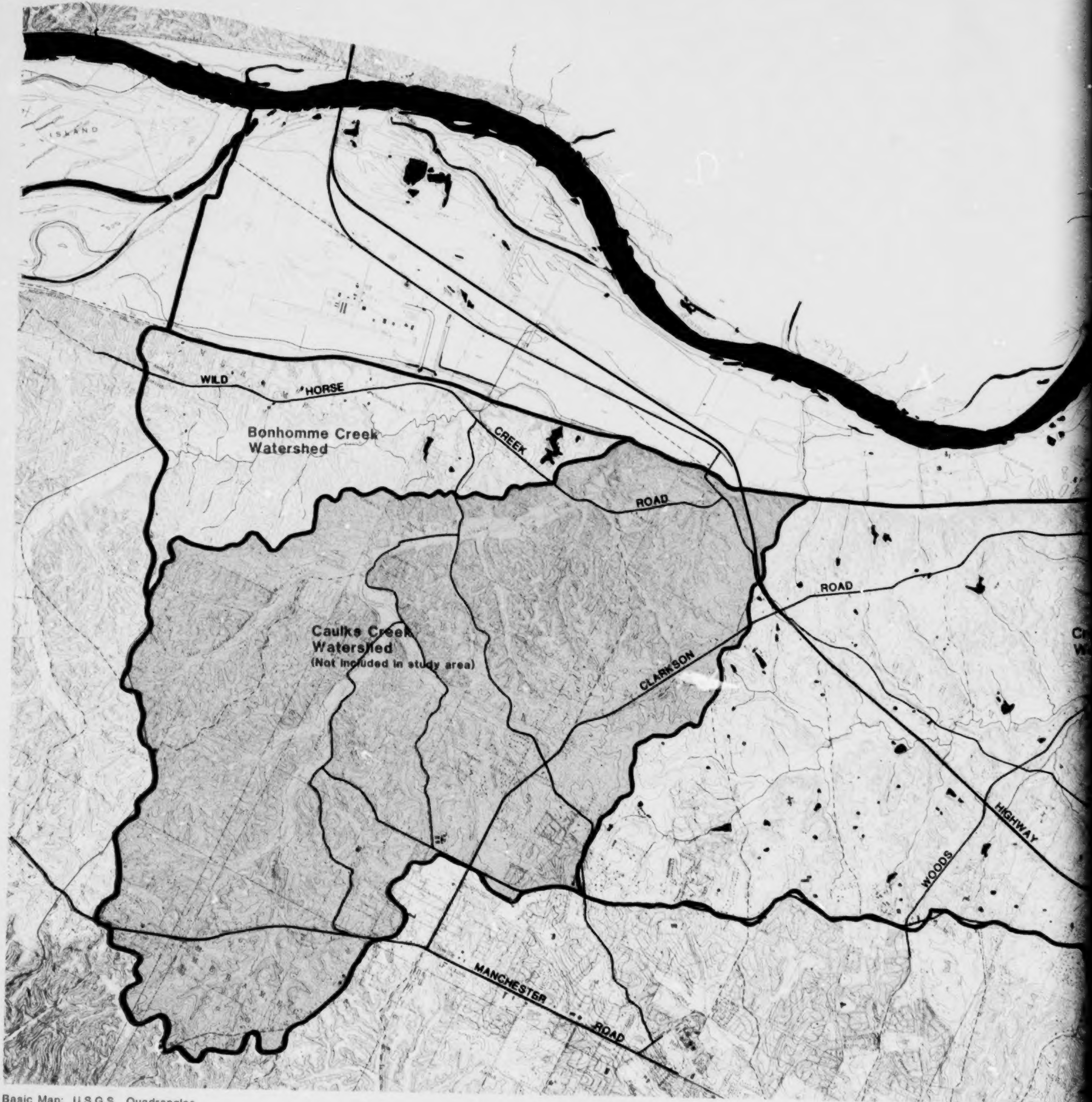
Map Prepared by: Shannon & Wilson, Inc.

PLATE 7

Prepared for
U.S. Environmental Protection Agency

Prepared by
Harland Bartholomew & Associates, Inc.

AQUATIC RESOURSES


ISLAND
WILD
HORSE
CREEK
ROAD
Bonhomme Creek
Watershed
Caulks Creek
Watershed
(Not included in study area)
ROAD
CLARKSON
MANCHESTER
ROAD
WOODS
HIGHWAY

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

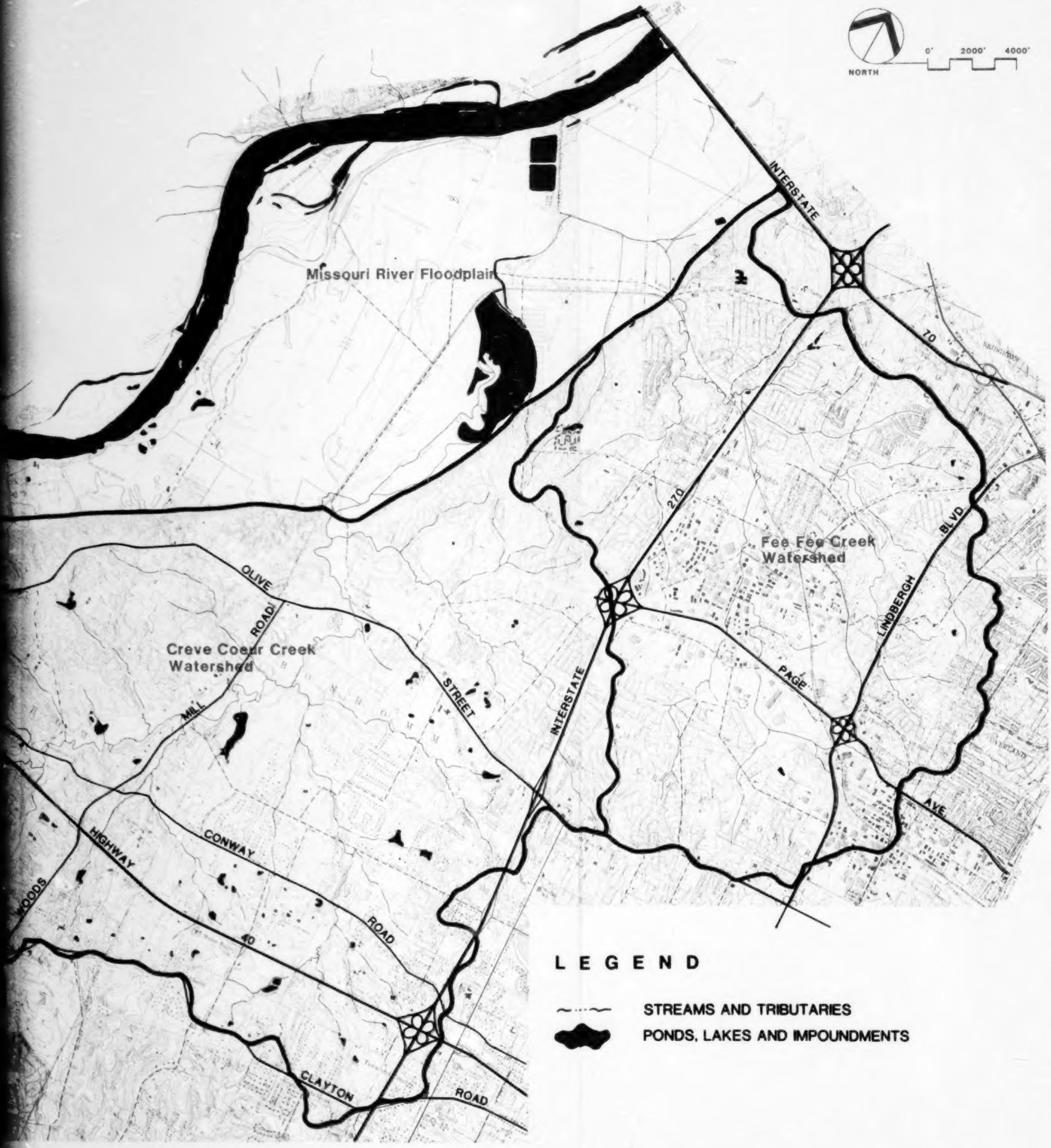

NORTH
0'
2000'
4000'
Missouri River Floodplain
INTERSTATE
70
Fee Fee Creek Watershed
270
LINDBERGH
BLVD
PAGE
AVE
OLIVE
ROAD
Creve Coeur Creek Watershed
STREET
INTERSTATE
MILL
CONWAY
ROAD
HIGHWAY
40
WOODS
CLAYTON
ROAD
LEGEND
STREAMS AND TRIBUTARIES
PONDS, LAKES AND IMPOUNDMENTS

PLATE 8

Table 1

MISSOURI WATER QUALITY STANDARDS[1]

Parameter	Units [2]	Protection of Aquatic Life	Irrigation	Livestock, Wildlife Watering	Coldwater[3] Fishery	Whole Body Contact Recreation	Drinking Water Supply
Barium	ug/l	5,000					1,000
Beryllium	ug/l	1,100	100				
Boron	ug/l		750				
Cadmium	ug/l	12	10		1.2		10
Chlorine							
(Total Residual)	ug/l	10			2		
Chromium	ug/l	100	100				50
Cobalt	ug/l			1,000			1,000
Copper	ug/l			500			1,000
Cyanide	ug/l	5					
Iron	ug/l	1,000					300
Lead	ug/l	50[4]					50
Manganese	ug/l						50
Mercury	ug/l	.05					2
Nickel	ug/l	100	200				
Selenium	ug/l						10
Silver	ug/l						50
Zinc	ug/l	100[4]	2,000				5,000
Chloride	mg/l						250
Sulfate	mg/l						250
Phenols	ug/l	1					1
Fluoride	mg/l			2.0			2.0
Ammonia Nitrogen (un-ionized)	mg/l	0.1			.02		
Nitrate Nitrogen	mg/l						10
Fecal Coliform	col/100ml					200	
Dissolved Oxygen (minimum)	mg/l	5			6		
Temperature	°F	90			68		
Temperature increase	°F	5			2		

Notes: 1. These standards are maximum values (unless otherwise specified) which apply to Class P (streams that maintain permanent flow even in drought periods) and Class P1 (standing water reaches of Class P streams, including impoundments) waters.

2. mg/l = milligrams per liter; ug/l = micrograms per liter; 1 mg/l = 1,000 ug/l; col/100ml = colonies per 100 ml; °F = degrees Fahrenheit.

3. All values for "protection of aquatic life" also apply, unless values listed in this column are more stringent.

4. If hardness exceeds 300 mg/l, lead standard is 100 ug/l and zinc standard is 300 ug/l.

Missouri River. The Missouri River is the major water resource in the study area and has a moderate to swift current, high turbidity, and a shifting sand substrate. The study area encompasses river miles 30 to 45. Common fish species in the river include buffalo, drum, carp, channel and flathead catfish, gar, and emerald shiners.

High turbidity in the river is a problem due, in part, to existing agricultural practices and activities such as construction and development which contribute sediment loadings to the river. Main stream dams have reduced this turbidity. High fecal coliform readings (indicators of the possible presence of pathogenic organisms) are common downstream of the major urban areas. Sulfate levels periodically exceed the drinking water standard of 250 mg/l. (See Table 2.)

Table 3 summarizes the applicable water quality standards as established in the Areawide Wastewater Treatment Management Study (208): Water Quality Evaluation for the City and County of St. Louis, dependent on the designated uses of waters. These standards are generally as strict as, or stricter than, the respective state standards promulgated by the Clean Water Commission of the Missouri Department of Natural Resources (DNR). The Missouri River has been designated as appropriate for all uses except secondary contact recreation (i.e., water skiing, canoeing, swimming) because it fails to meet the 200 colonies/100 ml fecal coliform standard during the recreation season. Table 4 also indicates possible violations of the ammonia nitrogen standards for the protection of fisheries. All other water quality parameters measured at this site meet the applicable standards.

Fee Fee Creek. Fee Fee Creek flows for six miles through the project area and into Creve Coeur Creek. The creek is designated a protected stream which means that discharges to this stream, other than uncontaminated cooling water, are prohibited. Fee Fee Creek is a Class P stream which indicates that it maintains permanent flow even in drought periods. Designated uses are livestock and wildlife watering, and warm water fishery.

Table 2

SUMMARY OF WATER QUALITY ANALYSES, MISSOURI RIVER MONITORING STATION: JEFFERSON CITY RECORD 1969-1975

Parameter	Units	Maximum	Minimum	Average
pH	—	8.7	6.8	7.8
Specific Conductance	umho/cm	900	300	607
Total Hardness	mg/l	400	128	235
Fluoride	mg/l	3.2	Less than 0.1	0.5
Sulfate	mg/l	400	20	136
COD	mg/l	230	6	38
Turbidity	Jackson Units	1,600	10	315
Dissolved Oxygen	mg/l	14	4	8
Dissolved Oxygen	% Sat.	108	38	81
Phosphorus	mg/l	3	0.15	0.56
Nitrate Nitrogen	mg/l	3.3	0.1	1.0
Fecal Coliform Bacteria	col/100 ml	24,000	100	1,827

Note: umho/cm = micromhos per centimeter; mg/l = milligrams per liter
col/100 ml = colonies per 100 milliliters
% Sat. = percent of saturation

Table 3

RECOMMENDED WATER QUALITY EVALUATION UNDER 208 CRITERIA
(all units in mg/l except as noted)

Parameter	Secondary Contact Recreation	Primary Contact Recreation	Aesthetics	Power Plant Cooling	Industrial Water Supply	Agricultural Irrigation	Wildlife & Livestock Watering	Public Water Supply	Warm Water Fishery	Cold Water Fishery
Alkalinity	-	-	-	500	80-150	-	30-130	-	20 minimum	20 minimum
Aluminum	-	-	-	3.0	-	5.0	5.0	-	-	-
Aquatic Growth	Virtually(1) free	Virtually(1) free	Virtually(1) free	-	-	-	No blue-green algae	-	-	-
Arsenic	-	-	-	-	-	0.10	0.2	0.05	0.05	0.05
Bacteria										
Fecal Coliform	1,000/100ml(3)	200/100ml(2)	-	-	-	1,000/100ml	-	2,000/100ml	-	-
Total Coliform	-	-	-	-	-	-	-	10,000/100ml	-	-
Barium	-	-	-	-	-	-	-	1.0	3.0	3.0
Beryllium	-	-	-	-	-	0.10	-	-	0.011-1.1(8)	0.011-1.1(8)
Bicarbonate	-	-	-	600	400	-	-	-	-	-
Boron	-	-	-	-	-	0.75	5.0	0.75	-	-
Cadmium	-	-	-	-	-	0.01	0.050	0.010	0.0004-0.015(8)	0.0004-0.015(8)
Calcium	-	-	-	500	200	-	-	-	-	-
Chloride	-	-	-	600	100	100	-	250	-	-
Chlorine	-	-	-	-	-	-	-	-	0.003	0.003
Chromium	-	-	-	-	-	0.10	0.05	0.050	0.05	0.05
Cobalt	-	-	-	-	-	0.05	1.0	-	-	-
Color	-	Virtually(1) free	Virtually(1) free	-	10 units(5)	-	-	75 units(5)	-	-
Copper	-	-	-	-	-	0.3	0.5	1.0	0.010-0.040(8)	0.010-0.040(8)
Cyanide	-	-	-	-	-	-	-	0.2	0.005	0.005
Floating Debris and Scum	Virtually(1) free	Virtually(1) free	Virtually(1) free	-	-	-	-	-	-	-
Fluoride	-	-	-	-	1.0	1.0	2.0	1.8(6)	-	-
Hardness	-	-	-	850	900	-	-	-	-	-
Iron	-	-	-	14	1.0	5.0	-	0.3	0.5	0.5
Lead	-	-	-	-	-	5.0	0.1	0.05	0.004-0.150(8)	0.004-.150(8)
Lithium	-	-	-	-	-	2.5	-	-	-	-
Magnesium	-	-	-	-	30	-	-	-	-	-
Manganese	-	-	-	2.5	.01	0.2	-	0.5	1.0	1.0
Mercury	-	-	-	-	-	-	0.0005	0.002	0.00005	0.00005
Nickel	-	-	-	-		0.20	-	-	0.050-0.100(8)	0.050-0.400(8)
Nitrogen										
Ammonia (NH_3-N)	-	-	-	-	0.5	-	-	0.5	0.020 un-ionized	0.020 un-ionized
Nitrate (NO_3-N)	-	-	-	30	8	-	-	10.0	-	-
Nitrite (NO_2-N)	-	-	-	-	-	-	10	1.0	-	-
Nitrite + Nitrate	-	-	-	-	-	-	100	-	-	-
Odor (Objectionable)	Virtually(1) free	Virtually(1) free	Virtually(1) free	-	Low	-	-	Virtually(1) free	-	-
Oil	Virtually(1) free	Virtually(1) free	Virtually(1) free	-	1	-	No visible floating	Virtually(1) free	No visible floating	No visible floating
Organics										
Carbon Chloroform Extract	-	-	-	-	-	-	-	0.7	-	-
Chlorophyll a	-	-	0-4 mg/m^3	-	-	-	-	-	-	-
Polychlorinated Biphenyls (PCB)	-	-	-	-	-	-	-	0.001	0.000001	0.000001
Oxygen, Dissolved	-	-	-	-	Aerobic	-	Aerobic	-	4.0-5.1(6)(9)(10)	4.0-5.1(6)(9)(10)
pH	-	6.5-8.0	-	6.0-8.0	6.5-9.0	4.5-9.0	7.0-9.2	5.0-9.0	6.5-9.0	6.5-9.0
Phenols	-	-	-	-	-	-	-	0.001	0.001	0.001
Phosphate (Total)	-	-	0.05(4)	4	-	-	-	-	-	-
Selenium	-	-	-	-	-	0.020	0.05	0.010	0.050	0.050
Silica	-	-	-	50	50	-	-	-	-	-
Silver	-	-	-	-	-	-	-	0.05	0.00010-0.00050(8)	0.00010-0.00025(8)
Solids										
Settleable	-	Virtually(1) free	Virtually(1) free	-	-	-	Minimized	-	-	-
Suspended	-	-	-	5,000	5,000	-	-	-	80	80
Total Dissolved	-	-	-	1,000	500	2,000	3,000(7)	100	2,000	2,000
Sulfate	-	-	-	680	570	200	-	250	-	-
Sulfide	-	-	-	-	0.2 H_2S	-	-	-	0.002 undissociated H_2S	0.002 undissociated H_2S
Temperature										
Minimum	-	15°C (59°F)	-	-	-	-	Avoid changes in freezing dates	-	-	-
Maximum	-	35°C (94°F)	-	38°C (100°F)	38°C (100°F)	-	-	-	29.9°C (85.9°F)	18.2°C (64.8°F)
Vanadium	-	-	-	-	-	0.10	0.1	-	-	-
Zinc	-	-	-	-	-	2.0	25.0	5.0	0.050-0.060(8)	0.050-0.040(8)

---

(1) Virtually free is used to imply freedom from the undesirable effects of the constituent itself. This recognizes the practical impossibility of complete absence and the inevitability of the presence of potential pollutants to some degree.
(2) Log mean of a minimum of five samples taken over 30 days. Ten percent of the total samples for any 30-day period shall not exceed 400/100ml.
(3) Log mean of a mimimum of five samples taken over 30 days. Ten percent of the total samples for any 30-day period shall not exceed 2,000/10ml.
(4) Suggested standard for streams. Suggested standard for lakes is 0.025 mg/l.
(5) Platinum-cobalt units.
(6) Based on the average annual maximum daily air temperature of 18.6°C (65.5°F).
(7) As close to natural conditions as possible. Rapid fluctuations should be minimized.
(8) Value dependent on the hardness as shown by Davies and Goettl, July 1976.
(9) See Figure 2.3 of source document.
(10) For streams which have low dissolved oxygen levels due to pollution, a minimum value is 5 mg/l.

Source: St. Louis, Missouri Water Quality Management Plan, Areawide Waste Treatment Management Study (208), East-West Gateway Coordinating Council, St. Louis MO, May 1978.

Table 4

MISSOURI RIVER WATER QUALITY ANALYSIS[1]

Parameter	Units[2]	Minimum	Maximum	Average
Calcium	mg/l	32.0	78.4	58.6
Magnesium	mg/l	7.3	25.7	19.6
Ammonia	mg/l	0.00	0.70	0.10
Fluoride	mg/l	0.15	0.55	0.39
Turbidity	NTU	4	4000	358
pH	-	7.9	8.7	8.2
Non-carbonate hardness	mg/l	22	98	66
Total hardness	mg/l	120	300	227
Color	color units	8	32	14
Suspended solids	mg/l	5	4658	364
Dissolved solids	mg/l	198	590	431
Odor	T.O.N.	1.0	5.3	2.4
Iron	mg/l	0.02	0.08	0.03
Chlorides	mg/l	11	27	20
Nitrates	mg/l	1.2	10.0	4.6
Ortho-phosphates	mg/l	0.10	0.38	0.26
Potassium	mg/l	4.8	6.0	5.3
Silica	mg/l	6.5	13.4	9.9
Sodium	mg/l	18	77	50
Sulfates	mg/l	55	214	143
Caustic alkalinity	mg/l	0	0	0
Carbonate alkalinity	mg/l	0	5	2
Bicarbonate alkalinity	mg/l	112	194	159
Specific conductance	umho/cm	369	810	664

[1] Daily analyses performed by St. Louis County Water Company near river mile 36 during 1979 and 1980.

[2] mg/l = milligrams per liter; NTU = Nephelometric Turbidity Units; T.O.N. = Threshold Odor Number; umho/cm = micromhos per centimeter.

Fee Fee Creek water quality data provided by the Metropolitan Sewer District (MSD) and the Missouri Department of Natural Resources (DNR) are presented in Table 5. Pollutant concentrations in the creek exceed standards for designated uses with respect to ammonia nitrogen, phenols, iron, and possibly copper.

Currently the Four Star Motel is discharging to the creek under a National Pollutant Discharge Elimination System (NPDES) permit which is valid until November, 1984 or within 90 days of notification of the availability of a trunk sewer line. The motel is allowed to discharge to this protected creek under a "grandfather" clause (i.e., the motel was discharging prior to adoption of the regulation).

Fee Fee Creek was inspected during a field visit in March 1981. The creek experiences severe bank erosion and excessive runoff from the impervious surfaces of numerous industrial areas draining to the creek. The water was noticeably green and slightly odorous, and much debris was present. A sparsity of vegetation was noted, which results in a lack of shading and high water temperatures, which reduce the stream's ability to support aquatic organisms.

Creve Coeur Creek. Creve Coeur Creek flows for two miles through the project area into Creve Coeur Lake. Outflow from the lake crosses the floodplain to empty into the Missouri River near river mile 31. The creek is a Class C stream which indicates a cessation of flow in dry periods but the maintenance of permanent pools which support aquatic life. The designated uses of the creek include warm water fishery, and livestock and wildlife watering.

Water quality data for Creve Coeur Creek obtained from MSD and DNR are presented in Tables 6 and 7. The standards for ammonia nitrogen, phenols, iron, and copper are exceeded.

Table 5

FEE FEE CREEK WATER QUALITY

Parameter	Units(1)	208 Water Quality Standards		DNR Samples(2)		MSD Samples(3)	
		Warm Water Fishery	Livestock & Wildlife Watering	Average(4)	Maximum	Average(4)	Maximum
pH	—	6.5-9.0		7.6	8.0(6)	—	—
Total Phosphate	mg/l			2.6	11.4	0.6	1.0
Ammonia Nitrogen	mg/l	0.02		0.4	0.9	0.5	0.8
BOD_5	mg/l			4.3	6.1	—	—
Phenols	mg/l	0.001		0.014	0.030	0.05	0.05
Iron	mg/l	0.5		1.33	6.05	—	—
Copper	mg/l	0.1-0.4(7)	0.5	0.44	2.48	—	—
Zinc	mg/l	0.5-0.6(7)		0.11	0.20	—	—
Total Coliform	col/100ml			350,000	2,000,000	—	—
Fecal Coliform	col/100ml			21,000	110,000	5,925(5)	130,000
Fecal Strep	col/100ml			11,000	82,000	—	—
Color	—			—	—	240	240
Oil	mg/l			—	—	1	1
Alkalinity	mg/l			—	—	163	204

Notes:
1. mg/l = milligrams per liter; col/100ml = colonies per 100 milliliters
2. Missouri Department of Natural Resources samples taken prior to November, 1976
3. Metropolitan St. Louis Sewer District samples taken at Vigus Road in April, August, and September, 1978
4. Arithmetic mean, except as noted
5. Geometric mean
6. Minimum is 7.1
7. Valve dependent on the hardness

Table 6

SUMMARY OF WATER QUALITY IN CREVE COEUR CREEK AS MONITORED BY MSD[2]

Parameter	Units[1]	Upper		Lower	
		Average	Maximum	Average	Maximum
pH[4]	—	—	—	—	—
Total Phosphate	mg/l	0.1	0.1	—	—
Ammonia Nitrogen	mg/l	0.2	0.2	0.2	0.2
BOD_5	mg/l	—	—	—	—
Phenols	mg/l	0.05	0.05	—	—
Iron	mg/l	—	—	—	—
Copper	mg/l	—	—	—	—
Zinc	mg/l	—	—	—	—
Total Coliform[3]	col/100ml	—	—	—	—
Fecal Coliform[3]	col/100ml	2,260	7,300	700	700
Fecal Strep[3]	col/100ml	—	—	—	—
Color	—	30	30	—	—
Oil	mg/l	1	1	—	—
Alkalinity	mg/l	181	238	92	92

Notes:

1. mg/l = milligrams per liter; col/100ml - colonies per 100 milliliters
2. Metropolitan St. Louis Sewer District samples taken in April and September, 1978; upper is upstream of Creve Coeur Lake, lower is downstream of Creve Coeur Lake
3. Geometric mean, except as noted
4. Range

Table 7

SUMMARY OF WATER QUALITY IN CREVE COEUR CREEK
AS MONITORED BY DNR[2]

Parameter	Units[1]	Upper		Middle		Lower	
		Average	Maximum	Average	Maximum	Average	Maximum
pH[5]	—	7.5	7.3 - 7.8	7.2	7.0 - 7.6	7.3	6.0 - 7.8
Total Phosphate	mg/l	1.4	1.6	0.7	2.0	5.5	9.2
Ammonia Nitrogen	mg/l	0.33	0.67	4.2	7.4	7.2	13.4
BOD_5	mg/l	3.8	6.6	29	42	88	151
Phenols	mg/l	0.030	0.070	0.022	0.040	0.148	0.650
Iron	mg/l	2.47	2.72	4.1	10.8	1.06	2.90
Copper	mg/l	0.06	0.12	0.05	0.23	0.03	0.07
Zinc	mg/l	0.07	0.08	0.11	0.20	0.11	0.32
Total Coliform[3]	col/100ml	33,000	40,000	770,000[4]	2,000,000	5,500,000	14,000,000
Fecal Coliform[3]	col/100ml	1,580	2,500	37,000[4]	180,000	550,000	1,700,000
Fecal Strep[3]	col/100ml	3,000	2,200	46,000[4]	110,000	1,000,000	6,000,000
Color	—	—	—	—	—	—	—
Oil	mg/l	63	63	—	—	—	—
Alkalinity	mg/l	—	—	—	—	—	—

Notes:
1. mg/l = milligrams per liter; col/100ml = colonies per 100 milliliters
2. Missouri Department of Natural Resources samples taken prior to November 1976; upper is upstream of Smith's Fork, including Smith Fork; middle is from Smith's Fork to Fee Fee Creek; lower is from Fee Fee Creek to mouth.
3. Geometric mean, except as noted
4. Arithmetric mean
5. Range

A field inspection of Creve Coeur Creek in March 1981 indicated that the creek has minimal bank erosion, low turbidity, and a variety of aquatic habitats (i.e., pool and riffle areas, ledges and underwater rock outcrops). The creek is bordered by woodland which provides the shading necessary for cool water temperatures and the support of aquatic organisms.

Smith Creek is a major tributary of Creve Coeur Creek and maintains standing water in the lower reaches where it joins the creek. The lower reaches may contain a light fishery due to the presence of aquatic habitats, minimal bank erosion, and low turbidity.

Bonhomme Creek. Bonhomme Creek flows for two miles through the study area and empties into the Missouri River near river mile 38. The creek is designated a Class C stream suitable for wildlife and livestock watering, and warm water fishery. At this time, the creek does not have protected status.

Water quality data obtained from DNR are presented in Table 8. Pollutant levels in the creek exceed the water quality standards for ammonia nitrogen, phenols, and iron.

A field inspection conducted during March 1981 indicated that the creek was composed of a gravel substrate with pool and riffle areas. Siltation was not a problem in the upper reaches of Bonhomme Creek, but turbidity was evident in the lower reaches below Wild Horse Creek Road, primarily due to exposed banks where sloughing was occurring. The creek had in-stream habitat consisting of snags, logs, and rock ledges. The creek is tree-lined along most of its course.

Creve Coeur Lake. Creve Coeur Lake is a 270-acre lake fed by Creve Coeur Creek. The lake is the largest lentic (standing water) resource in the study area and was formed from an old oxbow of the Missouri River. By state water quality standards, the lake is designated for uses such as livestock and wildlife watering, propagation of warm water sport fish, and protection of

Table 8

SUMMARY OF WATER QUALITY IN BONHOMME CREEK[1]

Parameter	Units [2]	Upstream of Caulks Creek		Downstream from Caulks Creek	
		Average	Maximum	Average	Maximum
pH	—	—	—	8.0	8.5[3]
Total Phosphate	mg/l	5.1	9.0	0.7	1.3
Ammonia Nitrogen	mg/l	3.6	11.1	0.6	3.2
BOD_5	mg/l	10	28	8	43
Phenols	mg/l	0.027	0.070	0.01	0.01
Iron	mg/l	1.29	3.26	1.00	3.40
Copper	mg/l	0.02	0.06	0.06	0.27
Zinc	mg/l	0.06	0.06	0.07	0.10
Total Coliform	col/100ml	88,000	230,000	55,000	100,000
Fecal Coliform	col/100ml	419	1,500	3,900	10,000
Fecal Strep	col/100ml	2,870	5,800	1,380	3,900
Oil	mg/l	7	7	—	—
Nitrate Nitrogen	mg/l	2.2	2.2	—	—

Notes:
1. Missouri Department of Natural Resources samples taken prior to November, 1976
2. mg/l = milligrams per liter; col/100ml = colonies per 100 milliliters
3. Minimum is 7.5

aquatic life. The Metropolitan Sewer District has analyzed samples from Creve Coeur Lake. (See Table 9.)

The lake, in the past, has experienced severe sedimentation and is currently being dredged by the St. Louis County Parks and Recreation Department under a grant from the Environmental Protection Agency. The dredging operation is expected to increase the depth and restore water quality in the lake.

Additional Water Resources. Numerous small lakes and ponds are located in the project area. Most are under private ownership and provide a variety of recreational opportunities including fishing, swimming, and small boating.

Water quality data are not available for these lakes and ponds. Field inspections indicated that many are experiencing advanced eutrophication (lake aging) as evidenced by excessive aquatic growth and decreasing lake or pond depth. Additional problems include bank erosion, loss of spillway and dam stability, and lack of adequate maintenance.

These small water bodies are important in providing aquatic and terrestrial species with habitat and water supply, especially during drought periods. Common fish species in the lakes and ponds include channel catfish, largemouth bass, bluegill, green sunfish, and bullhead.

Vegetation and Wildlife

Background. St. Louis County lies within the oak-hickory forest region, directly adjacent to the tall grass prairie biome. Fingers of prairie formerly extended into the north and western portions of Missouri. A long history of conversion of prairie to agriculture has virtually destroyed all but a few prairies. Oak-hickory forests have also been cleared for agriculture, pasture, and urban/suburban development. This trend continues, but native vegetation which remains in the study area shows most affinity to the oak-hickory forests of the

Table 9

CREVE COEUR LAKE WATER QUALITY(1)

Parameter	Units(2)	Inflow	Lake	Outflow
Flow	cfs	6.23	—	10.22
pH	—	7.4	7.9	7.9
BOD_5	mg/l	5.1	4.0	5.4
Chemical Oxygen Demand	mg/l	52	39	34
Kjeldahl Nitrogen	mg/l	1.7	1.5	1.8
Nitrate Nitrogen	mg/l	1.4	0.3	0.6
Nitrite Nitrogen	mg/l	0.1	0.1	0.1
Total Phosphate (as P)	mg/l	2.0	2.0	2.4
Ortho-Phosphate (as P)	mg/l	0.1	0.1	0.2
Total Coliform(3)	col/100ml	64,000	66,000	130,000
Fecal Coliform(3)	col/100ml	900	300	700
Chlorophyll	mg/l	—	0.1	—
Dissolved Oxygen				
1 ft. depth	mg/l, % sat	—	6.8, 85	—
2 ft. depth	mg/l, % sat	—	7.2, 89	—
3 ft. depth	mg/l, % sat	—	6.0, 74	—
Temperature	°C	—	27	—

Notes:

1. Samples taken by Metropolitan St. Louis Sewer District in August and September, 1978.
2. mg/l = milligrams per liter;
   cfs = cubic feet per second;
   col/100ml = colonies per 100 milliliters
   % sat = percent of saturation
3. Geometric mean

near east, south, and north. In 1973, forest cover in St. Louis City and County totaled approximately 68,900 acres, or 19.2 percent of all land in the area. St. Charles County, north of the Missouri River, had 86,600 acres of forest cover in 1973, or 24.6 percent of total county land.

In the study area, remaining woodland is predominantly second growth. Typical secondary succession which occurs after an oak-hickory forest has been cleared, is a sequential change from annual to perennial grasses and weedy forbs, to shrubs and sun-loving trees, and gradually to shade tolerant trees with a diversity of subcanopy and understory flora. The climax community would be realized in 100-200 years.

Plant and animal communities within forested or non-forested areas vary according to numerous factors including soils, topography, orientation, climate, previous land uses, and level of disturbance. In the study area, bottomland woods and forested slopes often occur next to drainage channels or next to ponds and small lakes which have been created in suburban developments. Old fields and pasture or spacious lawns with generous ornamental plantings also occur, frequently adjacent to fragmented upland woods and forested slopes. Wildlife value increases in those areas where the variety of habitats (i.e., old field, woodland and stream or pond) meet, providing corridors for wildlife movement, diversity in food resources, availability of cover, and requirements for nesting.

Additional values provided by the terrestrial communities which remain in the study area include: control of soil erosion and sedimentation, control of stormwater runoff, capturing airborne and waterborne pollutants, reducing noise levels, providing shade and conserving energy, increasing property values, acting as a visual buffer to industrial and commercial development, and providing recreational and aesthetic opportunities.

General Description. The study area contains forest land, cultivated land, old fields, pasture, floodplain, and developed land. Residential developments vary in density, with some providing substantial yard and lawn space and a variety of ornamental plantings or native shrubs and trees. Parks, country clubs, golf courses, and cemeteries also offer open space and native or introduced vegetation within the developed areas. (See Plate 9.)

The Missouri River floodplain and Bonhomme Creek watershed are the least developed portions of the study area with large tracts of remaining woodland and cultivated land surrounding low-density development. These areas, in addition to Creve Coeur Lake, its associated wetland, and the forested areas of the park and Creve Coeur Creek, offer valuable wildlife habitats. Development in the Creve Coeur Creek watershed is proceeding at a rapid rate but wooded borders remain along the creek and its tributaries with some large, wooded tracts such as on the grounds of Logan Chiropractic College, Maryville College, and the Hunter Farms estate.

Development in the Fee Fee Creek watershed is very dense with few existing wooded areas. Thin bands of timber remain along the creek. Large areas of industrial and commercial development occur in this watershed; most of the area is of little value to wildlife.

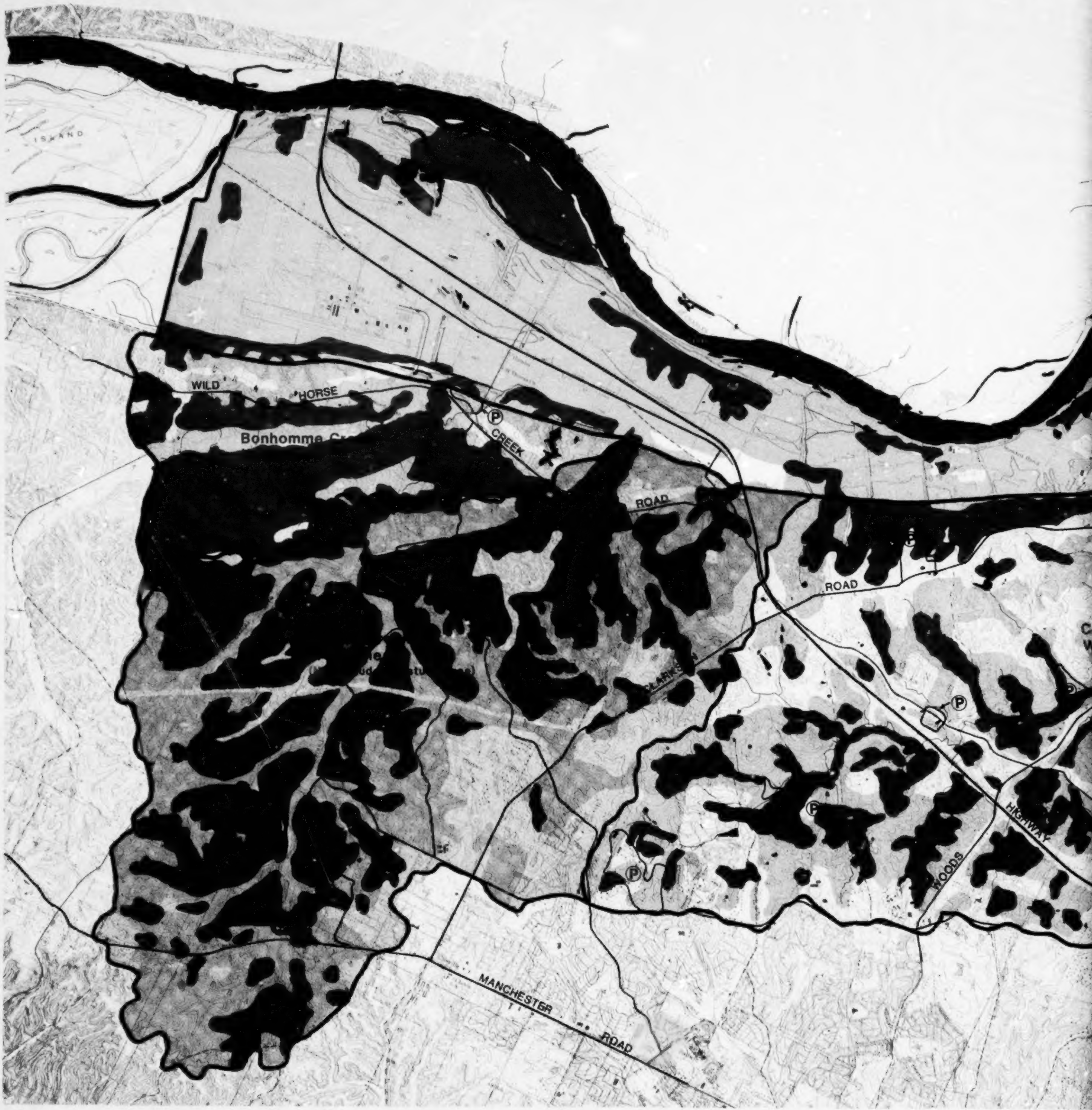
Habitat Types.

Upland Woods. All upland woods remaining in the study area are second growth with species such as white, black and red oak; post, chinquapin and blackjack oak on particularly dry sites; shagbark, mockernut and black hickory; and sugar maple. Redbud, dogwood, coral berry, Virginia Creeper, and poison ivy are common understory species. Spotted salamanders, tree frogs, wood frogs, and American toads are common amphibians in upland woods; skinks, box turtles, rat snakes, brown snakes, and worm snakes are common reptiles. Bird species include various woodpeckers, nuthatches, wrens, tufted titmouse, chickadees, blue jay, cardinal, thrushes and warblers. Mammals may include gray squirrel, rabbit, raccoon, red fox, white-

Prepared for
U.S. Environmental Protection Agency

Prepared by
Harland Bartholomew & Associates, Inc.

HABITAT AREAS


ISLAND
WILD HORSE
Bonhomme Cr
CREEK
ROAD
ROAD
CLARKE
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WOODS
MANCHESTER ROAD
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Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

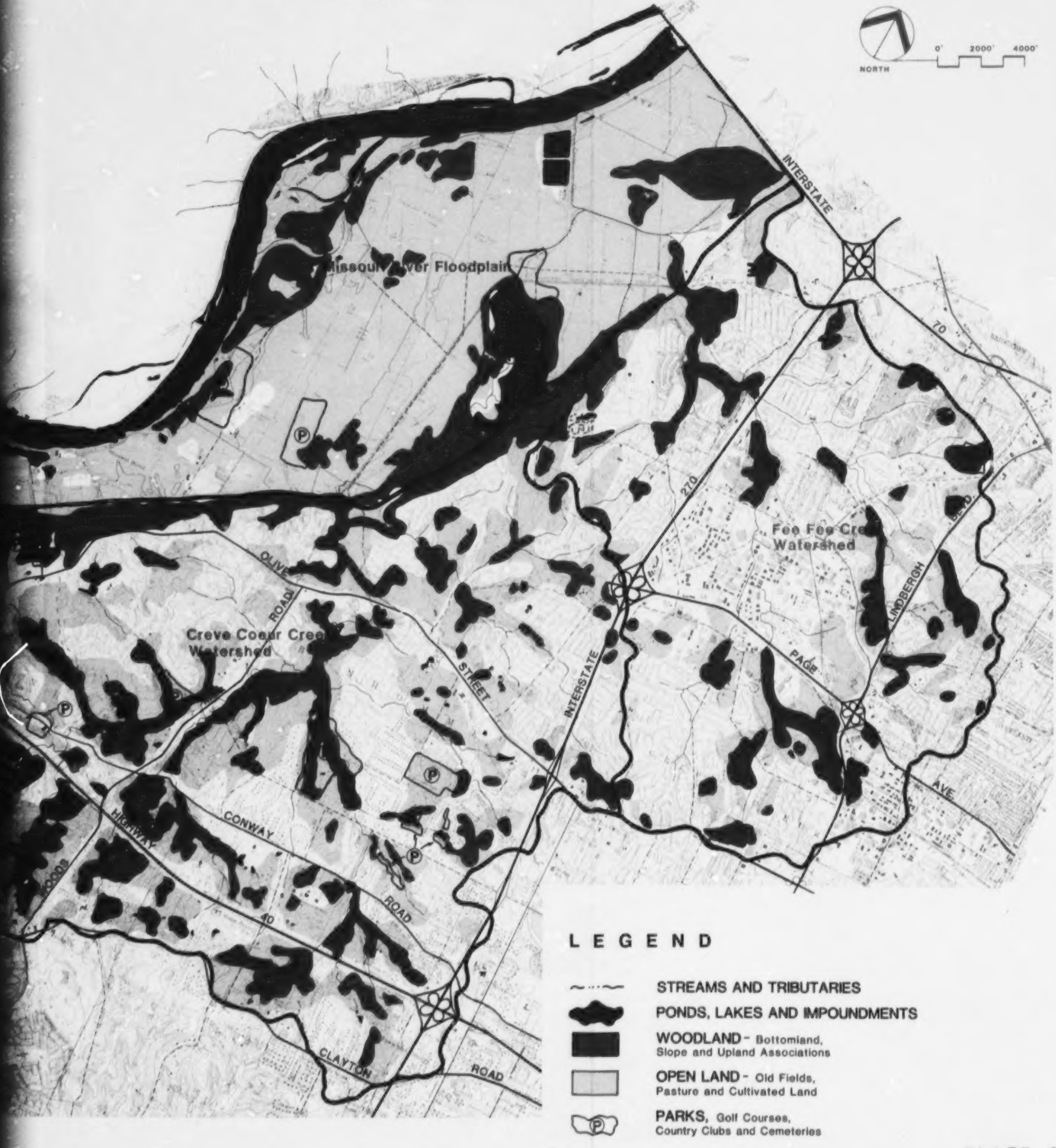

NORTH
0'
2000'
4000'
INTERSTATE
70
Missouri River Floodplain
270
Fee Fee Creek Watershed
LINDBERGH BLVD.
PAGE AVE
INTERSTATE
OLIVE STREET
ROAD
Creve Coeur Creek Watershed
CONWAY ROAD
HIGHWAY 40
WOODS
CLAYTON ROAD
P
LEGEND
STREAMS AND TRIBUTARIES
PONDS, LAKES AND IMPOUNDMENTS
WOODLAND - Bottomland, Slope and Upland Associations
OPEN LAND - Old Fields, Pasture and Cultivated Land
PARKS, Golf Courses, Country Clubs and Cemeteries

PLATE 9

tailed deer, short-tailed shrew, white-footed mouse, and various bats such as red, hoary, silver-haired, and little brown bats.

Upland forest in the study area is limited to a few remaining fragmented areas adjacent to steep slopes, drainage areas, power line rights-of-way or scattered development. Some developments maintain a certain amount of tree cover especially larger oaks and hickories, whereas others are stripped of vegetation altogether.

Forested Slopes. Forest which occurs on slopes of over five percent is more common in the study area since these areas presented constraints for cultivation and continue to limit development. Many were cut for timber, however, and second growth has occurred. Species composition is a mixture of upland and lowland species, again dependent on soil, direction, slope and climate. White, black and chinquapin oak are dominant on dry, upper south or southwest facing slopes; whereas, white oak, shagbark hickory and sugar maple dominate moist upper north or northeast facing slopes. Middle slopes contain above mentioned species in addition to northern red oak and pignut hickory, and lower slopes contain lowland species such as black walnut, American elm, and bitternut hickory. Fauna is similar to that of upland areas.

Bottomland Woods. Bottomland forests occur along the floodplain of the Missouri River, Fee Fee and Creve Coeur Creeks and portions of their tributaries within the study area. Willows, cottonwoods and silver maple dominate the frequently flooded riparian communities along the river and larger streams. Along the streams a variety of species are present such as box elder, green ash, mulberry and black walnut. Older floodplain woods contain sycamore, hackberry, American elm and oak species such as pin oak and bur oak. Understory vegetation in well-developed bottomland woods often contains wild grape, nettle, poison ivy, trumpet creeper, tall white aster, jewelweed, smartweed, violet, dogwood, and redbud. Many of the streamside communities in the study area have been disturbed, and secondary succession is obvious. Various brambles such as raspberry, rose, and strawberry crowd the area along with sumac, black cherry, ragweed, nettle, Japanese hops, and honeysuckle.

Bottomland woods remaining in the study area are essential to the continuance of wildlife populations in the area. These woodland borders provide access to water resources and corridors for wildlife movement. Amphibians such as bullfrogs, springpeepers, and leopard, chorus, tree, and cricket frogs; Fowlers toads; and small-mouth, spotted, and marbled salamanders are found along creeks and in bottomland communities in the study area. Reptiles frequently found in such habitats include: skinks, sliders, water snakes, garter snakes, and rat snakes. A variety of birds utilize these areas including herons, mallards, wood ducks, swamp sparrows, cardinals, juncos, towhees, and ruby-crowned kinglets. Mammals utilizing bottomland areas would include white-footed and house mice, striped skunk, cottontail rabbit, raccoon, opposum, woodchuck, fox squirrel, various bats, beaver, muskrat, red fox, and white-tailer deer.

Non-Forested Areas. Old fields, pastures, cultivated areas, and spacious yards or lawns represent additional habitat types in the study area. Crops such as corn, soybeans, alfalfa, and wheat are grown and attract species such as mice and shrews, moles and gophers, rabbit, woodchucks and white-tailed deer. Crows, bobwhite quail, field sparrows, mourning doves, meadowlarks, red-wing blackbirds, red-tailed hawks and kestrels frequent these areas. Common reptiles and amphibians include black rat snakes, prairie king snakes, skinks, American toads, and chorus frogs.

The transition zones between old fields and woodlands offer a high diversity of vegetation and are particularly valuable to wildlife. Plant and animal species common to both woodland and field areas occur in these edge communities.

Residential areas may support a variety of urban-tolerant species depending on the density of development and the amount and type of plantings in yards, lawns, and along streets. Squirrels, rabbits, opposums, and raccoons are common mammals in developed areas. Birds such as starlings, grackles, robins, blue jays, cardinals, sparrows, and night hawks are also common.

Wetlands. A few wetland areas exist within the Missouri River floodplain, but most have been drained or filled for agricultural purposes. One large wetland occurs along Creve Coeur Creek directly upstream of the lake and smaller wetland areas can be found along Creve Coeur Creek, even farther upstream. Both swamp and marsh wetland areas are present. Willow and cottonwood are common in swampy areas and cattails, sedges, rushes, and grasses in marshy areas.

Numerous species of amphibians utilize these areas including spring peepers; leopard, green, cricket, chorus, and bull frogs; tiger, marbled, spotted, and small-mouth salamanders; newts, and mud puppies. A variety of snakes and turtles inhabit wetland areas, as well as waterfowl and shorebirds.

Rare and Endangered Species. Many of the rare and endangered species of plants and animals known to occur in the vicinity of St. Louis County require habitats which are not found in the study area, such as wet prairies, swamp areas, rich woods, and glades. A natural areas inventory was recently completed for St. Louis County by the Missouri Department of Conservation. None of the eight areas identified as natural areas, geologic areas or natural study areas in the county are located within the study area. No endangered or relict species habitat was located in St. Louis County by the inventory.

Over 70 percent of the habitat areas affected by the Proposed Action are either open, cultivated or pasture land, old fields, shrubby borders or developed land, incapable of providing for the requirements of rare and endangered species.

Of the woodland affected, most of it is highly altered and disturbed, in close proximity to development, or fragmented by roads and structures; thus, state-designated rare and endangered species are not generally expected to occur here. (For a discussion of federally-designated rare and endangered species habitat requirements, the reader is referred to the following chapter on environmental consequences.)

Appendix Table A-2 lists state- and federally-designated rare and endangered species which have been known to occur in the St. Louis County area.

Air Quality

Meteorology. Meteorological conditions influence the relationship between air pollutant emissions and ambient air quality. Warm, moist air from the Gulf of Mexico and cold air from Canada alternately move through the St. Louis area, resulting in a wide range of conditions. Meteorological data, based on approximately 20 years of record are summarized in Appendix Table A-3.

On an annual basis, southerly winds dominate in the St. Louis area, blowing about 12 percent of the time. Seasonally, winds tend to blow from the west and west-northwest during the winter, and from the south during the spring, summer, and fall. An annual wind rose for St. Louis is presented in Appendix Plate A-1.

Annual and seasonal stability class distributions for St. Louis are presented in Table 10. Classes A, B, and C are representative of sunny days during which the surface layer is heated and vertical convection currents are produced, resulting in the rapid dilution of air pollutants. However, these unstable classes are relatively uncommon in the St. Louis area, occurring only about 16 percent of the time on an annual basis. Class D is attributable to the occurrence of cloudy and windy conditions, which counteract the phenomena (insolation and thermal radiation) responsible for surface layer stratification. Classes E and F are representative of clear nights with calm to moderate wind conditions, during

Table 10

ATMOSPHERIC STABILIY CLASS FREQUENCIES BY SEASON AT ST. LOUIS, MISSOURI

Percentages

Season	A	B	C	D	E	F
Winter	0.0	0.8	5.9	30.8	39.6	22.9
Spring	0.6	4.9	9.5	29.1	32.2	23.7
Summer	1.8	10.0	16.8	27.1	11.0	33.3
Autumn	0.1	3.3	9.5	24.5	29.5	33.1
Annual	0.6	4.8	10.5	27.9	28.0	28.2

Class A	represents extremely unstable conditions, with a great deal of vertical mixing.
Class B	represents unstable conditions which provide slightly less mixing.
Class C	represents slightly unstable conditions.
Class D	represents neutral/day conditions where mixing is poor.
Class E	represents neutral/night conditions.
Class F	represents stable inversion conditions.

which the surface layer cools and the resulting dense air near the ground resists vertical mixing. These neutral and stable conditions (Classes D, E, and F) are fairly evenly distributed in St. Louis, each occurring about 28 percent of the time.

The atmospheric mixing height is the distance above the ground to which air pollutants are relatively free to disperse in the atmosphere. Low mixing heights result in greater ambient ground level air pollutant concentrations, because pollutants cannot disperse upward. Table 11, which presents seasonal and annual average mixing heights for the St. Louis area, indicates that summer mornings are the most restrictive for atmospheric mixing of air pollutants.

Existing Ambient Air Quality. Table 12 presents recent ambient air quality monitoring data representative of the Lower Missouri River study area, along with the applicable National Ambient Air Quality Standards (NAAQS). Primary standards are intended to prevent adverse effects on human health, while secondary standards are intended to prevent all other potentially adverse effects on human welfare, plant and animal life, materials, the atmosphere, etc. The locations of the air monitoring sites, with respect to the study area, are shown on Plate 10.

Particulate levels are within standards, though the maximum 24-hour level on Harold Drive exceeds the secondary standard (one such excess per year is allowable), and the annual geometric means on Harold Drive and in St. Ann (on St. Charles Rock Road) exceed the secondary guideline (which is intended for compliance planning, but is not a standard protecting against adverse effects). Therefore, particulate levels in the study area may be considered marginally acceptable. This condition is attributed to dust and smoke from highway traffic, commercial and domestic fuel combustion (for space heating, etc.), and construction activities (including operations at the Fred Weber construction materials facility adjacent to the Missouri River Wastewater Treatment Plant).

Table 11

MEAN ATMOSPHERIC MIXING HEIGHTS
AT ST. LOUIS, MISSOURI

(meters)

Season	Morning	Afternoon
Winter	500	900
Spring	500	1,600
Summer	300	1,700
Autumn	400	1,400
Annual	400	1,400

Note: Interpolated from Figures 1-10 of George C. Holzworth's Mixing Heights, Wind Speeds, and Potential for Urban Air Throughout the Contiguous United States, U.S.E.P.A., Publication AP-101, January 1972.

Table 12

AMBIENT AIR QUALITY DATA REPRESENTING THE LOWER MISSOURI RIVER BASIN STUDY AREA[a]

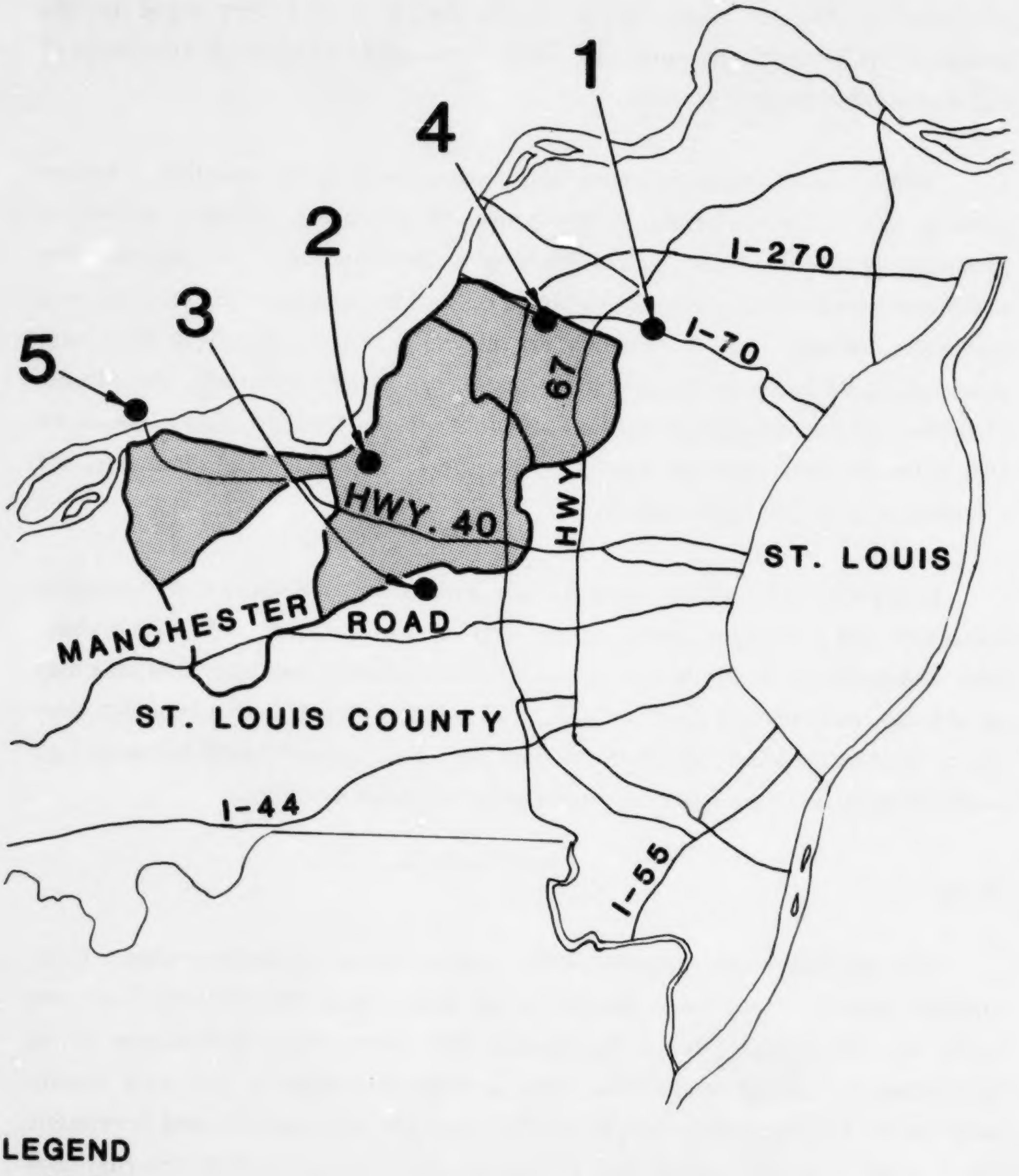
(ug/m^3)

Air Contaminant	Averaging Period	Ambient Standard		Harold Dr.		Ladue & Olive		Queeny Park		St. Ann		Weldon Spr.	
		Primary[b]	Secondary[c]	Max.	2nd Hi	Max.	2nd Hi	Max.	2nd Hi	Max.	2nd Hi	Max.	2nd Hi
Particulate Matter	24 hr	260	150	154	120	141	111	111	108	118	111	—	—
	1 yr[d]	75	60[e]	66	—	43	—	50	—	68	—	—	—
Sulfur Dioxide	3 hr	—	1,300	676[f]	655[f]	—	—	686[f]	637[f]	764[f]	668[f]	486	470
	24 hr	365	—	234	182	—	—	109	107	231	208	142	139
	1 yr	80	—	44	—	—	—	37	—	46	—	28	—
Nitrogen Dioxide	1 yr	100	100	24	—	—	—	43	—	38	—	—	—
Carbon Monoxide	1 hr	40K[g]	40K	11.2K	11.2K	—	—	12.1K	12.1K	24.3K	20.1K	—	—
	8 hr	10K	10K	9.4K	7.8K	—	—	8.0K	7.6K	11.5K	9.9K	—	—
Ozone	Max. hr./day	235	235	306	298	—	—	494	362	480	392	—	—

Notes:

a. Particulate data for 1980 except at Ladue & Olive (1979 data); gaseous data for 1978, the latest year compiled, except at Weldon Spring (1980 data)
b. Health-related standard
c. Welfare-related standard
d. Geometric mean, for particulate matter only
e. Guideline for planning to meet the 24-hour secondary particulate standard
f. One-hour data (greater than 3-hour data)
g. K = 1,000

LOCATION OF AMBIENT AIR QUALITY MONITORING STATIONS REPRESENTATIVE OF THE LOWER MISSOURI RIVER BASIN STUDY AREA


1
4
2
3
5
I-270
I-70
67
HWY
HWY. 40
ST. LOUIS
MANCHESTER
ROAD
ST. LOUIS COUNTY
I-44
I-55

LEGEND

1. Harold Dr.
2. Ladue & Olive
3. Queeny Park
4. St. Ann
5. Weldon Spring

PLATE 10

Regarding the gaseous air contaminants, sulfur dioxide and nitrogen dioxide levels are well within applicable standards. Carbon monoxide levels are also within standards, though the eight-hour standard was exceeded once (which is allowable) at St. Ann, and the second-highest level was very close to the standard. This marginally acceptable carbon monoxide situation is attributed to highway vehicle exhaust emissions.

Ozone, a contaminant formed in the atmosphere by the reaction of hydrocarbons and other materials in the presence of strong sunlight, occurs at maximum levels of about twice the applicable standard. The hydrocarbon emissions result from highway vehicle operation, gasoline distribution and marketing, solvent use (in painting, dry cleaning, etc.), incomplete stationary source combustion (in cooking, heating, etc.), and other activities. The effects of ozone and accompanying reaction products include the irritation of sensitive tissues (in the eyes, nose, throat, etc.), damage to vegetation and materials, and a reduction in atmospheric visibility.

Localized odor problems occasionally occur near inefficient and overloaded collection and treatment facilities, as well as near polluted receiving waters. Odor characteristics vary with the levels of the different contaminants that may be present, such as hydrogen sulfide. This gas has a boiled or rotten egg odor which can be smelled at levels in the part per billion range (though levels as high as 10,000 ppb, or 10 ppm, are not considered to threaten health).

Noise

The existing wastewater collection and treatment facilities generate little ambient noise. Sound level measurements taken near lift stations L-51 and L-52, and the Missouri River Wastewater Treatment Plant (with a pair of its 500-horsepower motor-compressor units in operation) indicate that such nearby noise sources as highways (whose traffic near the lift stations and treatment plant includes a high percentage of trucks), St. Louis-Lambert International

Airport approach and departure paths, and the Fred Weber Company construction material facilities are the determining factors of ambient noise levels.

Energy

The existing wastewater collection and treatment facilities are dependent upon electrical energy for the operation of pumps, compressors, lights, and other equipment. This energy is supplied by the Union Electric Company, which burns almost a pound of coal (or fuel with a gross heating value of about 10,000 British thermal units, or Btu) to generate each kilowatt-hour (kwh) of electricity.

The existing Missouri River Wastewater Treatment Plant consumes 7.3 million kwh annually. Lift stations L-51 and L-52, in pumping wastewater to the plant, consume 1.2 million kwh annually. Facilities in the Bonfils area consume 1.0 million kwh annually, and facilities serving the Bonhomme Creek/Caulks Creek/Missouri River floodplain areas consume 0.1 million kwh annually. Total consumption of these existing collection and treatment facilities equals 9.6 million kwh (or about 96 billion Btu of fuel) annually. Most of this consumption is attributed to the operation of a pair of 500-horsepower air compressors (with a third unit standing by) for the aeration of the Missouri River Wastewater Treatment Plant's contact stabilization process.

Solid Waste

The existing Missouri River Wastewater Treatment Plant generates approximately 2,100 tons per year of digested sludge, and 690 tons per year of grit and screenings. The sludge is placed in one of the on-site lagoons (which could accommodate the waste well beyond the design life of any treatment facilities being considered for the site) pending the implementation of a plan for its ultimate disposal. The grit and screenings are placed in an on-site landfill.

Socioeconomic Environment

Population

The total population in the study area in 1978 was estimated in the 201 Facility Plan to be 99,327. This estimate was further broken down according to watershed as follows: Fee Fee Creek, 48,602; Creve Coeur Creek, 50,030; Bonhomme Creek, 458; and the Missouri River floodplain, 232. The estimate was made by multiplying the dwelling unit count by an average persons-per-household figure of 3.15, derived from 1970 Census figures.

Based on 1980 census tract data (not available when the initial study was done), the actual household size is 2.71, and the interpolated 1978 household size is 2.87 persons. Total population in the study area in 1978, using this estimate, would have been 90,577 persons, 8.8 percent below the previously estimated population. Applying the 2.87 household size to the study area uniformly, the 1978 population by watershed would have been distributed as indicated in Table 13. The watersheds represent all phases of new and maturing suburban residential development. However, detailed information on age, income, race, and occupation is not yet available from the 1980 Census.

Essential public services and facilities in the study area are provided by certain jurisdictions, together with the State of Missouri. Taxes are levied by each to support these services and facilities. Most of the study area is in unincorporated St. Louis County, as shown on Plate 11. The predominant school district in the study area is the Parkway School District which includes almost all of the Creve Coeur watershed and a substantial portion of the Fee Fee Creek watershed. (See Table 14.) The predominant fire protection district in the study area is the Chesterfield district. Others are the Ballwin, Creve Coeur, Maryland Heights, West Overland, and Pattonville fire protection districts.

Table 13

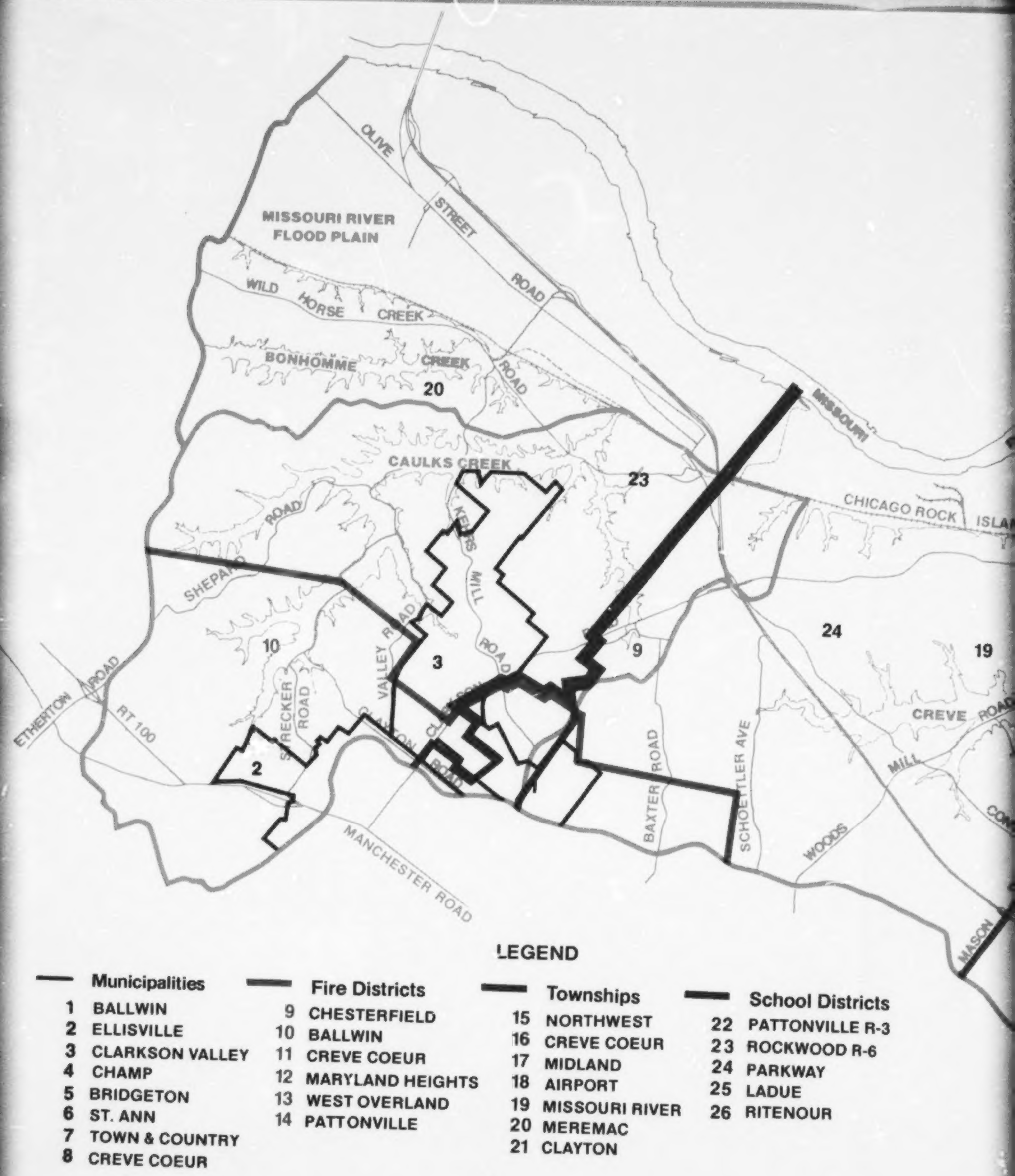
ESTIMATION OF 1978 POPULATION

Watershed	Dwelling Units	Estimated Population
Creve Coeur Creek	16,183	46,445
Fee Fee Creek	15,139	43,449
Bonhomme Creek	158	453
Floodplain	80	230
Total	31,560	90,577

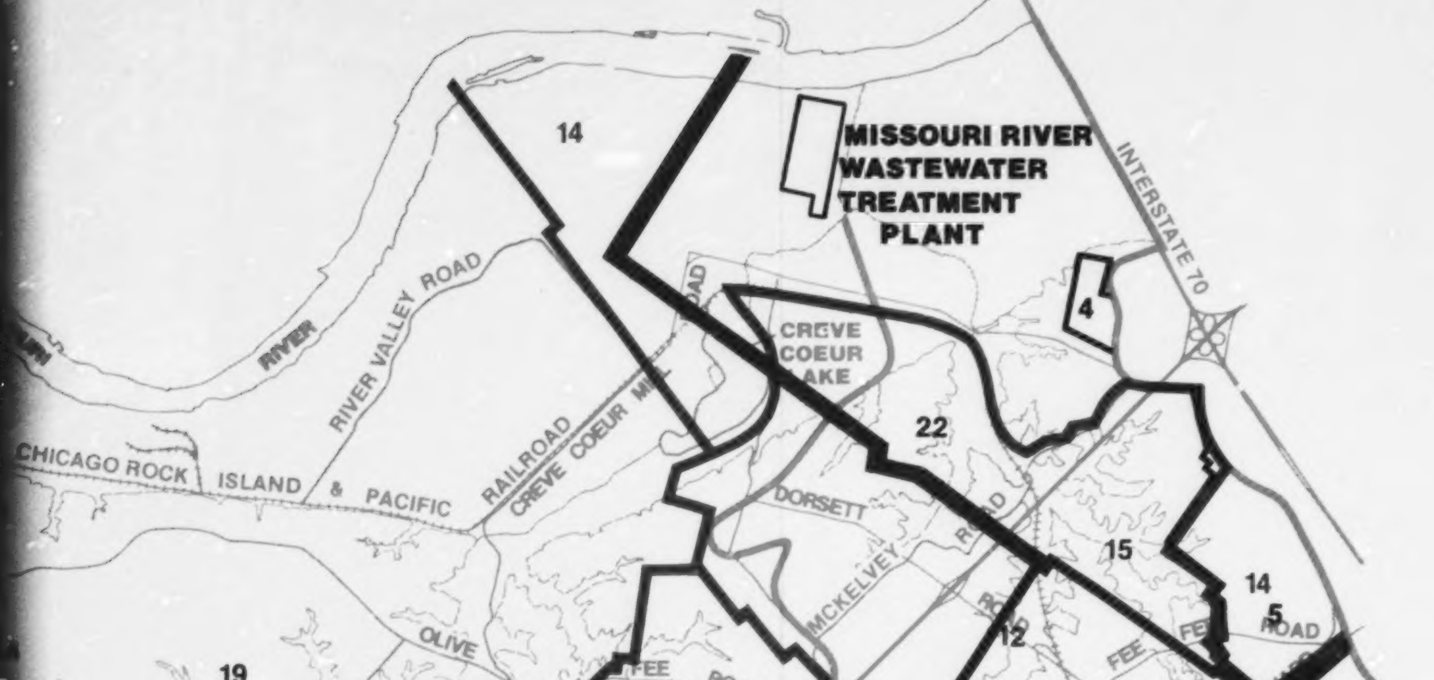
Table 14

STUDY AREA POLITICAL JURISDICTIONS AND SCHOOL DISTRICTS

Watershed		Political Jurisdictions	School Districts
Lower Bonhomme Creek	-	St. Louis County (unincorporated)	Rockwood
Creve Coeur Creek	-	St. Louis County (unincorporated) Ballwin Town and Country Creve Coeur	Parkway Rockwood
Fee Fee Creek	-	St. Louis County (unincorporated) Creve Coeur St. Ann Bridgeton Champ	Parkway Pattonville Ritenour Ladue
Floodplain	-	St. Louis County (unincorporated)	Rockwood Parkway Pattonville


MISSOURI RIVER
FLOOD PLAIN
OLIVE
STREET
ROAD
WILD
HORSE
CREEK
BONHOMME
CREEK
ROAD
20
MISSOURI
CAULKS CREEK
23
CHICAGO ROCK ISLA
ROAD
SHEPARD
KEHRS
MILL
ROAD
VALLEY
ROAD
3
10
9
24
19
ETHERTON
ROAD
RT 100
SRECKER
ROAD
CLAYTON
CLARKSON
ROAD
2
CREVE
ROAD
MILL
BAXTER
ROAD
SCHOETTLER AVE
WOODS
MANCHESTER ROAD
MASON
LEGEND
Municipalities
1 BALLWIN
2 ELLISVILLE
3 CLARKSON VALLEY
4 CHAMP
5 BRIDGETON
6 ST. ANN
7 TOWN & COUNTRY
8 CREVE COEUR
Fire Districts
9 CHESTERFIELD
10 BALLWIN
11 CREVE COEUR
12 MARYLAND HEIGHTS
13 WEST OVERLAND
14 PATTONVILLE
Townships
15 NORTHWEST
16 CREVE COEUR
17 MIDLAND
18 AIRPORT
19 MISSOURI RIVER
20 MEREMAC
21 CLAYTON
School Districts
22 PATTONVILLE R-3
23 ROCKWOOD R-6
24 PARKWAY
25 LADUE
26 RITENOUR

Lower Missouri River Basin Study Area


14
MISSOURI RIVER WASTEWATER TREATMENT PLANT
INTERSTATE 70
4
RIVER
RIVER VALLEY ROAD
CREVE COEUR LAKE
CREVE COEUR MILL ROAD
CHICAGO ROCK ISLAND & PACIFIC RAILROAD
22
DORSETT
MCKELVEY ROAD
15
14
5
FEE FEE ROAD
12
OLIVE
19
CREEK
FEE FEE ROAD
ROSS ROAD
18
6
CREVE COEUR ROAD
MILL
11
FEE FEE CREEK
16
17
13
CONWAY
LADUE
ROAD
INTERSTATE 270
ROAD
SCHUETZ ROAD
26
MASON ROAD
8
ROAD
25
N
21
Districts
LLE R-3
D R-6
7

ADMINISTRATIVE DISTRICTS

PLATE 11

Land Use

The study area consists of 47,901 acres, of which 29,306 or approximately 60 percent are in Creve Coeur Creek and Fee Fee Creek watersheds. (See Table 15.) These watersheds are predominantly urban in character.

Development in the study area has generally taken place in east-to-west and north-to-south directions. (See Plate 12.) The Fee Fee Creek watershed developed initially along Lindbergh Boulevard and then spread west to Interstate 270 and beyond. The Creve Coeur Creek watershed included early subdivisions and small towns throughout its area; however, concentrated development has occurred along both sides of Olive Street, along Ladue and Clayton Roads. Development is densest west of Woods Mill Road and north of Olive Street Road.

Residential development in the study area includes small lot, single-family development in the eastern portion of Fee Fee Creek watershed; medium lot, single-family development west of I-270 in both watersheds; and multi-family developments at I-270 & Dorsett, I-270 & Page, and along Olive Street Road. Two major industrial sites are located in the study area: the Maryland Heights area in the Fee Fee Creek watershed at I-270 & Page, and the Spirit of St. Louis Industrial Park in Chesterfield Valley.

In both the Creve Coeur and Fee Fee Creek watersheds, the remaining development consists primarily of residential infilling---principally single family in the Creve Coeur watershed and multi-family in the Fee Fee Creek watershed. The Bonhomme Creek watershed is virtually undeveloped; future development is expected to be of low density.

Infill Development. Only five percent of the land area in the Fee Fee Creek watershed is vacant and subject to future development (being outside floodplains and not already platted or included in approved development plans). These "developable" vacant areas are surrounded by intensive urban development

Table 15

LAND USE BY WATERSHED - 1978

Lower Missouri River

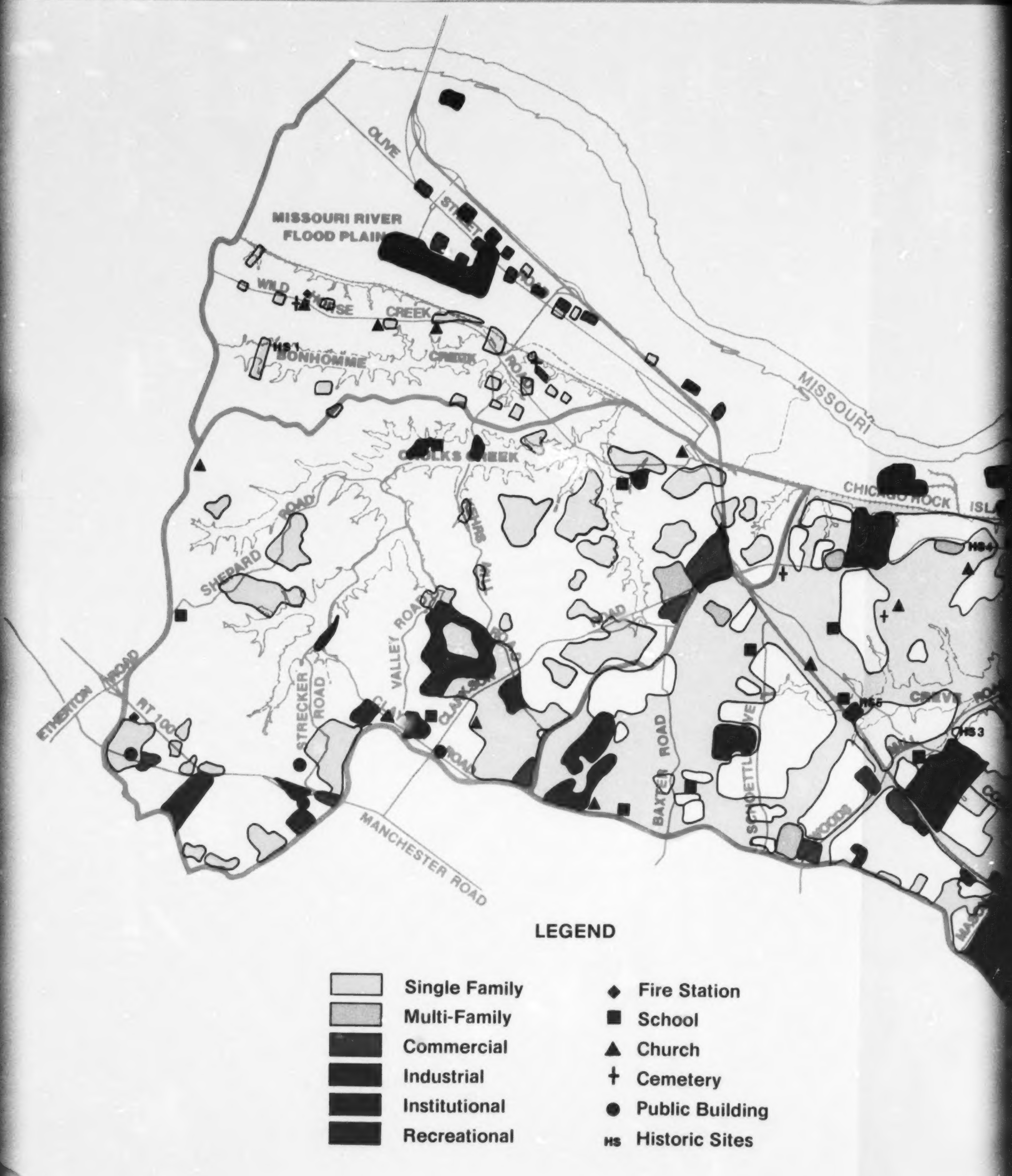
	Area (Acres)	Residential Acreage	Housing Density - Developed Areas (Units/acre)
Creve Coeur[(1)]	18,591	10,584	1.53
Fee Fee[(1)]	10,715	5,789	2.76
Subtotal	29,306	16,373	1.91
Bonhomme[(1)]	3,260	430	.37
Flood Plain[(1)]	15,335	78	1.03
Total	47,901	16,881	1.87

---

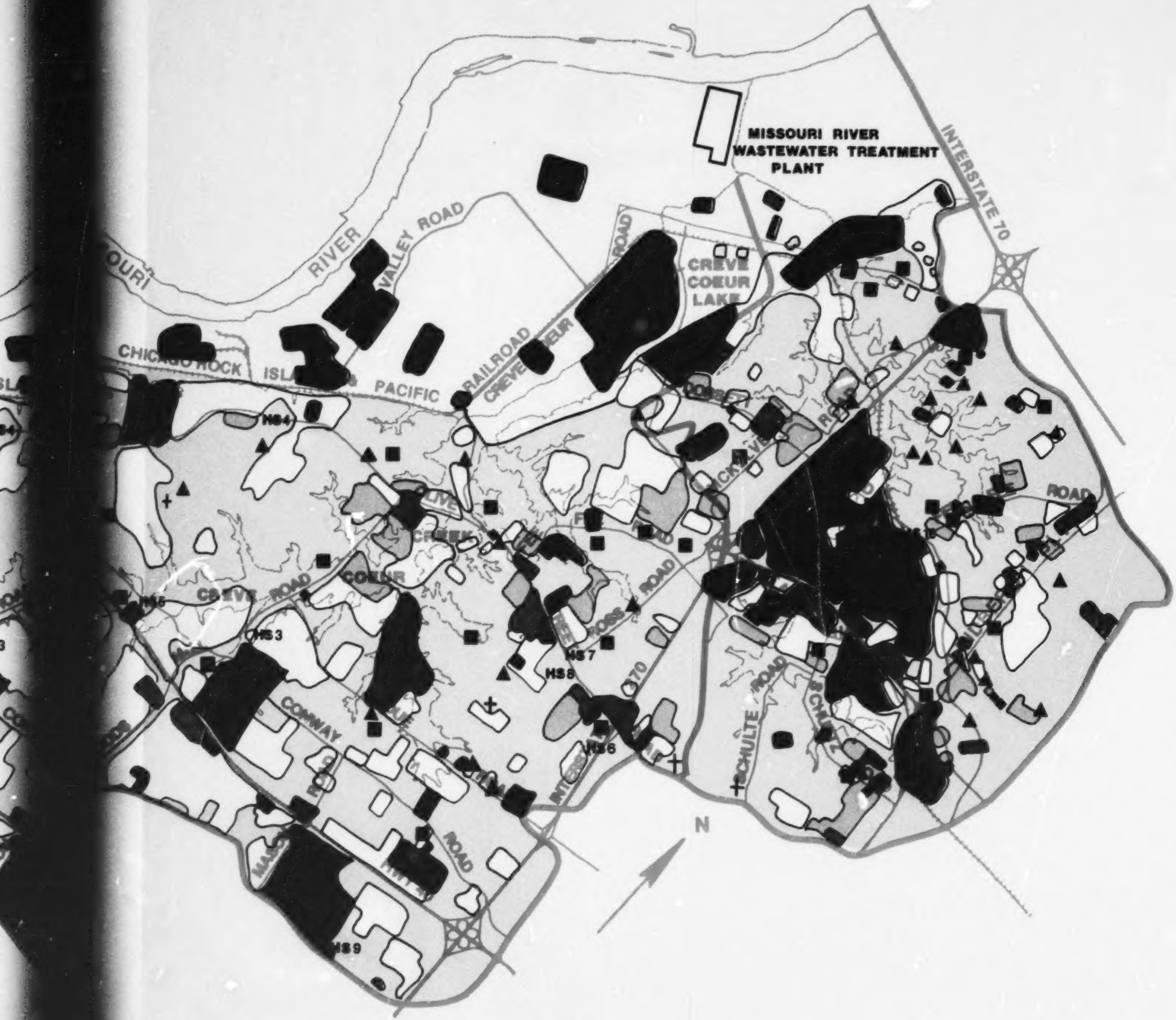
(1) Housing Units -

Creve Coeur	16,183
Fee Fee	15,139
Bonhomme	158
Flood Plain	80
	31,560

Source: Sverdrup & Parcel and Associates, Inc., op. cit., p. 50.


MISSOURI RIVER
FLOOD PLAIN
OLIVE
STREET
ROAD
WILD
HORSE
CREEK
HS 1
BONHOMME
CREEK
ROAD
MISSOURI
CAULKS CREEK
CHICAGO ROCK
ISL
HS4
SHEPARD
ROAD
ROAD
ROAD
VALLEY
ROAD
CLARKSON
ROAD
ETHERTON
ROAD
RT 100
STRECKER
ROAD
BAXTER
ROAD
HS5
HS3
CREVE
ROAD
WOODS
MANCHESTER ROAD
LEGEND
Single Family
Multi-Family
Commercial
Industrial
Institutional
Recreational
◆ Fire Station
■ School
▲ Church
+ Cemetery
● Public Building
HS Historic Sites

Lower Missouri River Basin Study Area


MISSOURI RIVER WASTEWATER TREATMENT PLANT
INTERSTATE 70
CREVE COEUR LAKE
RIVER VALLEY ROAD
CHICAGO ROCK ISLAND & PACIFIC RAILROAD
CREVE COEUR ROAD
CREVE COEUR CREEK
ROAD
FEE FEE ROAD
ROSS ROAD
CONWAY ROAD
SCHULTE ROAD
SCHUETZ
370
INTERSTATE
ROAD
HS3
HS4
HS5
HS6
HS7
HS8
HS9
N

EXISTING LAND USE

(AS OF JAN. 1979)

PLATE 12

consisting of industrial uses (manufacturing and warehousing) in the Page/Dorsett corridor and residential areas in the remainder of the watershed. The residential areas are a mixture of moderate density single-family and multi-family development with supporting public and institutional uses.

Development in the Creve Coeur Creek watershed is less intense, but may also be classified as urban in character. Approximately 15 percent of the land in the watershed can be considered developable. Most of this land is located in the central portion of the watershed, and the remainder is scattered. The entire 820 acres of developable land is presently zoned for urban development, and the remaining land is zoned for non-urban use. The non-urban classification would permit some low-density residential development, but typically has been used as a "holding" category. As the county develops, this land can then be rezoned to allow for the higher intensity urban land uses.

Development Plans. St. Louis County adopted its General Plan in May 1981. The plan is a broad document stating goals and policies for the following elements of County government:

Transportation
Government
Housing
Business & Industry
Environmental Quality
Recreation, Culture, Open Space
Energy
Health
Human Services
Criminal Justice
Land Use

The plan is not predicated upon assumptions regarding sewer availability, or the effects of providing such services on population distribution.

The General Plan Future Land Use Map serves as a development guide for the unincorporated study area. (See Plate 13.) The Future Land Use Map, which is a graphic representation of county policies regarding growth and development, is to be utilized in conjuncion with those policies as a guide to decision-making. Key guidelines of the plan for the study area include:

- Predominantly residential infilling of upland areas in both the Creve Coeur and Fee Fee watersheds with supportive commercial development at key intersections of major thoroughfares.

- Suburban residential development in the lower reaches of the Bonhomme Creek watershed, with agricultural/non-urban development in the remainder.

- Agricultural/non-urban or recreational designation for the floodplain with the following exceptions:

  Expansion of industrial use of the Chesterfield Valley area (Spirit of St. Louis Airport, etc.)

  Industrial use of the land east of the Earth City Expressway

  Designation of certain land north of Creve Coeur Lake Park and east of Creve Coeur Mill Road as "Unprotected floodplain that requires additional study. New open space with industrial potential." (This designation is presently being considered by St. Louis County.)

The portions of the study area included in the cities of Bridgeton, Creve Coeur, and St. Ann are also subject to local plans. Ballwin has prepared a plan which is being considered for adoption by its Board of Aldermen.

Transportation System. Major elements of the regional street and highway system are located in the study area. These include Interstate 270, US 40 and 61, Lindbergh Boulevard, Olive Street Road, Clayton Road, Page Avenue, Woods Mill Road, and Creve Coeur Mill Road.

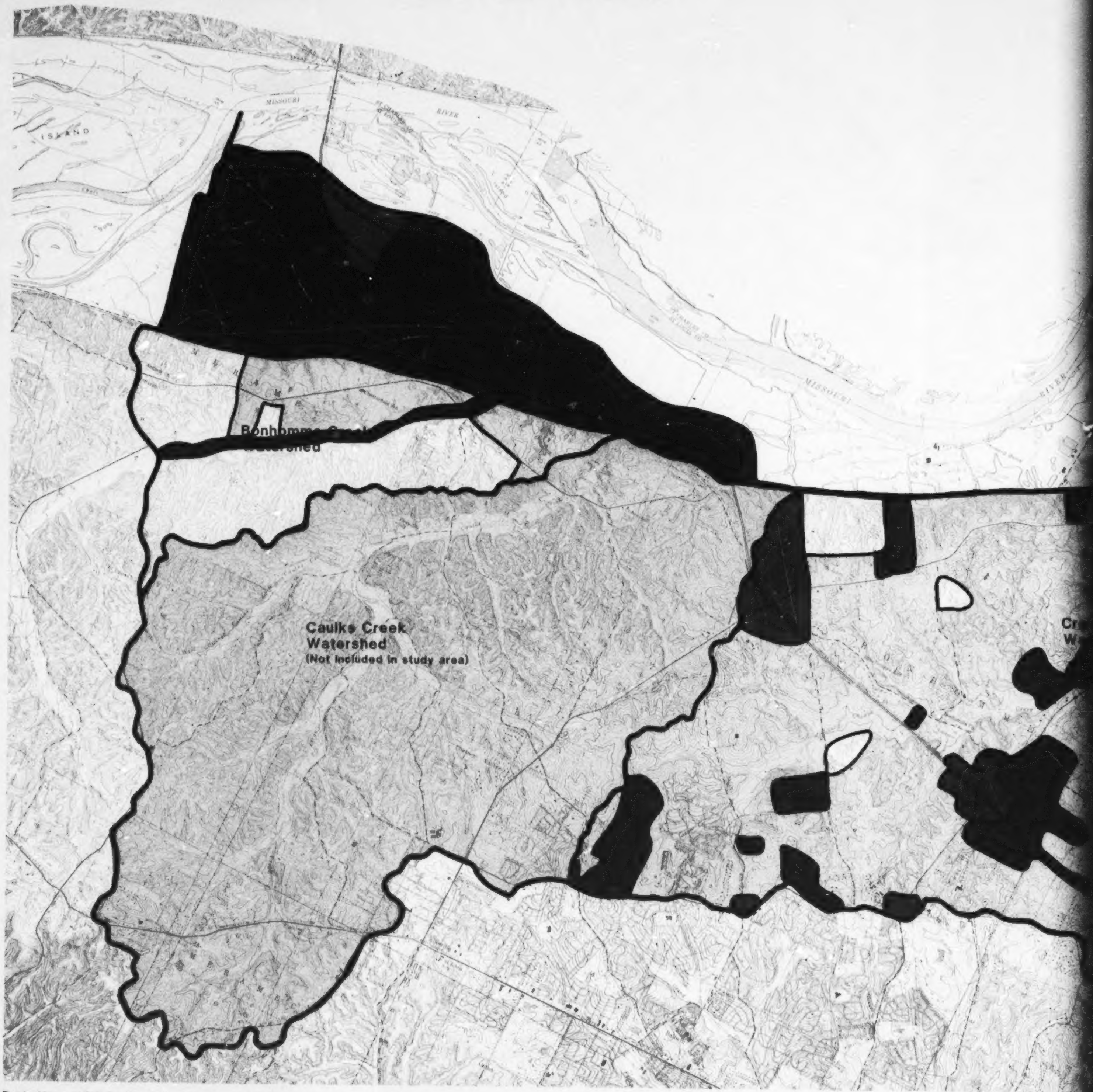
Planned thoroughfare extensions shown on the Future Land Use Map for the study area include:

Prepared for
U.S. Environmental Protection Agency

Prepared by
Harland Bartholomew & Associates, Inc.

LAND USE PLAN

St. Louis County


ISLAND
MISSOURI
RIVER
MISSOURI RIVER
Bonhomme Creek Watershed
Caulks Creek Watershed
(Not included in study area)

Basic Map: U.S.G.S. Quadrangles
Photorevised 1974

Lower Missouri River Basin Study Area

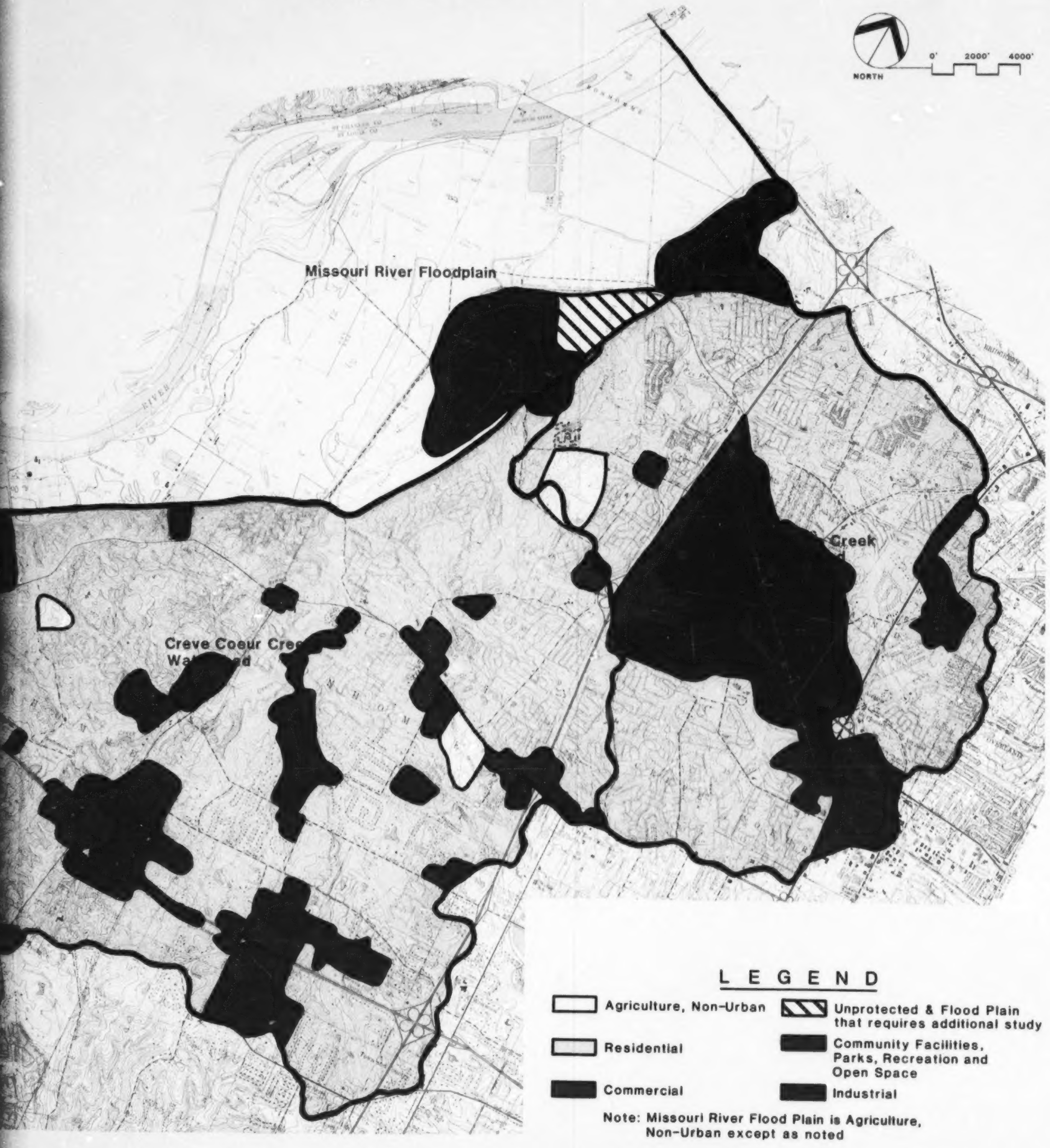

NORTH
0'
2000'
4000'
Missouri River Floodplain
Creve Coeur Cre
Wa ed
Creek
L E G E N D
Agriculture, Non-Urban
Residential
Commercial
Unprotected & Flood Plain that requires additional study
Community Facilities, Parks, Recreation and Open Space
Industrial
Note: Missouri River Flood Plain is Agriculture, Non-Urban except as noted

PLATE 13

- Page Avenue from I-270 to St. Charles County
- Creve Coeur Mill Road relocated to the Earth City Expressway

Cultural Resources

Historic and Archaeological Resources. During the development of the 201 Facilities Plan, archaeological investigations were conducted in the Missouri River Floodplain and in areas where new sewer lines will be constructed. Clearance for construction in these areas has been received from the State Office of Historic Preservation.

Table 16 lists historic sites and buildings within the study area including the Bonhomme Creek Archaeological District which was listed on the National Register of Historic Places in 1974. This district encompasses the portion of the study area between Bonhomme Creek and Wild Horse Creek Road.

Parks and Open Space. In the study area, parks and open space include local, state, and county parks, country clubs, golf courses, common grounds, and cemeteries. These areas are expected to remain as park and open space, not subject to future development.

County parks include Creve Coeur County Park, 1,260 acres located at Dorsett Road and Marine Avenue, and Faust County Park, 98 acres at Olive Street Road and Arrowhead Heights Lane. Creve Coeur Park contains a 270-acre lake which offers extensive recreational opportunity. There are numerous small tracts of land owned by municipal departments of parks and recreation. No state parks exist in the project area, although Babler State Park lies just outside the western boundary of Bonhomme Creek watershed.

Table 16

HISTORIC SITES AND BUILDINGS

Lower Missouri River Basin Study Area

Map No.	Name of Site	Location	Significant Date	Theme	Level of Significance	Ownership	National Register
1	Bonhomme Creek Archaeological District	Vicinity of Wild Horse Creek Road	Prehistoric	Archaeological	National	Private (mostly)	X
2	Fick Store	Old Etherton	1850	Architectural	Local	Private	-
3	"Thornhill"-Frederick Bates House	Olive Street Road Faust County Park	1807	Architectural	National	Private	X
4	Manchester Methodist Church	Woods Mill Road	1856	Architectural	Local	Private	-
5	Farmhouse	Olive Street Road	1858	Architectural	Local	Private	-
6	Old Bonhomme Church	Conway Road	1841	Historical	National	Private	X
7	Lake School House	Coeur de Ville Drive	1897	Architectural	Local	Public	-
8	Tappmeyer Farm	Olive Street Road	1884	Architectural	Local	Private	-
9	Herman H. Hackman Log House	Olde Cabin Road	1820s	Architectural	Local	Public	-
10	Des Peres Presbyterian Church	Geyer Road	1834	Architectural Historical	Local	Private	-
11	Musick Baptist Church	Fee Fee Road	1811	Architectural Historical	National	Private	X

SOURCES: Historic Sites Inventory, East-West Gateway Coordinating Council, June, 1976.

201 Facility Plan for the Lower Missouri River Basin Study Area, Sverdrup and Parcel and Assoc., Inc., October 1979.

Country clubs and golf courses located in the study area include: the Meadowbrook and Bellerive Country Clubs in the Creve Coeur watershed, the Chesterfield Golf Club in the Missouri River floodplain, and Green Trails Golf Course in Creve Coeur watershed. Common ground areas are tracts of lands usually set aside during residential development for use and enjoyment by all property owners, who generally pay a small fee for maintenance. Many of the area are along tributaries and drainage channels.

Four major cemeteries are located in the study area. These are the Gumbo Cemetery in the Bonhomme Creek watershed, the Conway and Hiram Park Cemeteries in the Creve Coeur watershed and the Fee Fee Cemetery in the Fee Fee Creek watershed. There are numerous other smaller cemeteries located at or near church properties.

Economics of Wastewater Management

The current cost of wastewater management in the study area is approximately \$1.3 million annually (in 1979 dollars). Adding the \$0.2 million annual expenditure in the Bonfils and Caulks Creek treatment plant areas (which would also be served under the Lower Missouri River Basin facility plan), the total cost is about \$1.5 million annually. Although the Missouri River Wastewater Treatment Plant (as taken over from the Fee Fee Trunk Sewer Company, and repaired by MSD), the remaining decentralized treatment facilities, and the associated sewer system do not have the capacity to accommodate the existing wastewater flow, operating costs are considered to be excessive because of high aeration and maintenance requirements. The continuing aging of the facilities results in ever-increasing operating and maintenance costs, even while the system's collection and treatment performance deteriorates.

ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES AND PROPOSED MITIGATION

Natural Environment

Geology/Hydrology

The impacts of the Proposed Action and Alternatives upon geological and hydrological systems can be divided into two types. These include: impacts which are characterized by their sudden nature, such as flash flooding, rapid subsidence over sinks, and landslides; and impacts which involve a change in natural processes over an extended period of time, such as acceleration of soil creep on slopes.

The impacts of the Proposed Action are related primarily to construction activities. Serious impacts are more likely to occur during construction and involve constraints which, to a large extent, can be alleviated through proper construction practices. All impacts of the Proposed Action, with the possible exception of those related to karst topography, tend to be localized and of short duration. However, there is potential for long-term impacts from both construction and maintenance operations. For example, removal of cover during excavation over solutioned bedrock may accelerate sink collapse in karst topography. Collapse could occur at any time over the life of the collection systems, creating a potential for groundwater contamination. Such collapses would be localized to the immediate vicinity of construction.

In areas where steep slopes are present, such as along the bluff line and in some of the upland areas, construction activities may result in increased slope instability. Slope failures include slides, slumps, and erosion. These failures may be initiated by construction due to removal of cover, steepening of slopes, modification of drainage, and dewatering excavations during construction. These impacts will be localized and temporary.

Impacts which will result from construction of the treatment facility are directly related to its location on the Missouri River floodplain, where flood protection levees must be extended. Construction of a levee will reduce the limits of the floodplain. However, this reduction, which is estimated to be 21 acres in the case of the Proposed Action and six acres for the Subregional Alternative, will not affect river hydrology or present floodplain delineation. A detailed analysis of the various system components of the Proposed Action indicates that there are no serious potential impacts which cannot be overcome by proper construction practice and other mitigating action. A permit will be required from the U.S. Army Corps of Engineers in order to construct the additional levee, but no application has yet been filed.

More severe and longer-term impacts may result if increased development of the area is facilitated by the presence of sewage treatment systems. Most of these impacts will be similar to those from construction of the Proposed Action, or Subregional Alternative, although the impacts may be more widespread and enduring, depending on the degree of development. Increased development will result in a corresponding increase in impervious surfaces in the area. Roads, parking lots, roof tops, and compacted soils will result in faster runoff and higher peaks during flash flooding and may lessen recharge to groundwater as well as to the root zone. However, since the adoption of a wastewater management approach is not expected to significantly induce or retard development, effects on flooding and groundwater are not anticipted. (See discussion of socioeconomic consequences.)

The No Action Alternative would, in the short-term, avoid those impacts related to construction of the Proposed Action. Impacts would occur from required maintenance of the existing system although these, too, would tend to be localized and short-term. Repairs would result in the same impacts indicated for construction of the proposed system. However, because of the emergency nature of system failures and the probability that they will occur during high-flow periods, such impacts would be more difficult to mitigate through proper construction procedures. Portions of the existing system traverse karst topography and present the same potential impacts as the Proposed Action.

The Subregional Alternative will have, essentially, the same geological and hydrological impacts as the Proposed Action, as described above.

Impacts in the areas of geology and hydrology may be largely avoided through proper construction procedures. Such mitigating actions include construction during the dry season, reduction of the time of excavation, regrading and revegetation, slope and vegetative cover maintenance, temporary stream diversions and stream control.

Construction during the dry season would help to avoid problems related to slope instability and dewatering requirements. This action in combination with reduction of time of excavation, including sequential excavation and cover, should effectively minimize such problems. Alternatively, temporary stream diversion and sediment control may be employed for this purpose. Potential impacts can be further reduced by immediate regrading and revegetation, followed by periodic slope and vegetative maintenance. Sink holes subject to collapse may be avoided by rerouting sewer lines and relocating other system components, or by proper foundation design including piers and bridging. Severe erosion problems along drainage ways and slopes may be alleviated through establishment of vegetative cover, reduction of slope grade, benching and terracing, and the placement of riprap and other channel protection devices.

Water Quality and Aquatic Resources

Water Quality. Upgrading the existing sewers and pump stations would eliminate the current backups and bypasses which occur in the study area and would result in improved localized water quality. This would reduce the health hazard potential and improve the aesthetic quality of water resources in the study area. Peak flows to the new Missouri River Wastewater Treatment Plant would be reduced because of the elimination of most of the inflow and infiltration problems. Raw and inadequately treated wastewater would no longer be discharged to the Missouri River and Creve Coeur Creek during periods of heavy rainfall.

Discharge of plant effluent to the Missouri River would result in improved water quality in Creve Coeur Creek. In addition, the elimination of discharges from the Caulks Creek Interim Wastewater Treatment Plant and several small treatment facilities in the study area would result in improved water quality of the surface waters which presently receive this effluent.

During a severely low flow in the Missouri River, wastewater treatment effluent would be diluted at a ratio of at least 100 to 1 (BOD and suspended solids concentrations less than 0.3 mg/l), and during normal flow the dilution would be at least 2,000 to 1 (BOD and suspended solids concentrations less than 0.015 mg/l), resulting in a minimal adverse impact on water quality.

Aquatic Resources. The Proposed Action would involve construction crossing of Fee Fee and Creve Coeur Creeks and their associated tributaries, and construction which parallels those streams. Impacts include the disruption of bottom sediments at creek crossings, increased erosion resulting in higher suspended solids, turbidity, and sedimentation and removal of streamside vegetation.

In-channel construction disrupts bottom sediments and destroys benthic habitats. This sediment disturbance also resuspends materials previously trapped in sediment layers, including any which may be harmful (heavy oils or sludges, construction debris, heavy metals, etc.).

Construction activities leading to increased erosion and sedimentation would result in increased turbidity and suspended solids in the creeks. This can be detrimental to successful egg and larval development of fish and other aquatic organisms. Increased turbidity would reduce light penetration, thus lowering aquatic vegetation productivity which could result in decreased oxygen levels. (Excessive aquatic vegetation can also be detrimental to a water body by decomposing and reducing oxygen levels in the process.) Excessive erosion restricts stream flow and prevents migration of some aquatic organisms. In addition, sight-feeding fish such as mosquito fish and some shiners and minnows may be hampered in finding food because of increased turbidity.

Removal of streamside vegetation would reduce shading and result in increased water temperatures, adversely affecting certain aquatic species. Vegetation removal may also detract from the aesthetic appearance of the creeks.

Most of these impacts would be short-term and could be mitigated within one year as new vegetation stabilizes the affected areas.

The severity of the impacts is dependent upon the proximity of construction activity to the creeks, construction techniques, frequency, duration and amount of rain during construction, and the gradient and flow characteristics of the creek system. Improper construction practices can cause excessive destruction of vegetation, soil compaction or increased erosion, resulting in long-term impacts to aquatic resources. However, the proper employment of mitigating measures by MSD should be sufficient to eliminate or greatly reduce any long-term impacts of the project.

Impacts of the Subregional Alternative on water quality and aquatic resources would be similar to those discussed under the Proposed Action. Continued operation of the Caulks Creek Wastewater Treatment Plant would result in the discharge of effluent to Bonhomme Creek. However, the effluent is expected to cause no significant adverse impact on the water quality of Bonhomme Creek.

Measures for the mitigation of adverse impacts on aquatic resources are included in MSD's "Standard Construction Specifications for Sewers and Drainage Facilities," and "Rules and Regulations and Engineering Design Requirements for Sanitary Sewerage and Storm Water Drainage Facilities." These documents require that contractors follow prescribed procedures to minimize the impacts of sewer facility construction. For example, one of the specifications provides that:

> The length of the trench which may be opened in advance of the completed sewer shall be limited to 200 feet...

This specification helps to insure that the potential for gully erosion is diminished, reducing runoff and subsequent stream sedimentation.

With No Action, undersized and deteriorating sewer lines and pump stations would continue to cause bypasses of raw sewage to surface water resources and backups into homes during periods of heavy rainfall. This can result in serious health hazards as well as aesthetic and odor problems. With continued development in the study area, average daily flows would likely increase. During dry weather periods, exfiltration would occur, leading to a potential groundwater contamination problem. Peak flows exceeding existing levels would result in the pumping of inadequately treated wastewater to lagoons and surface waters. The discharge of inadequately treated effluent (BOD and suspended solids both greater than 30 mg/l) from the Missouri River Wastewater Treatment Plant can be expected as the average daily flow continues to increase beyond design flow.

The St. Louis County Correctional Institute is the only existing wastewater treatment facility (besides the Missouri River Treatment Plant) able to meet its NPDES permit requirements. Other facilities with NPDES permits (i.e., Spirit West Air Park, Four Star Motel, Principia School and Artronix) are either reporting unsatisfactory results or none at all. Without proper maintenance and operation, they would continue to discharge inadequately treated effluent to receiving streams resulting in excessive aquatic growth, decreased oxygen levels, fecal contamination, and excessive BOD and suspended solids creating conditions hazardous to human health and aquatic organisms.

Vegetation and Wildlife

The primary impact of the Proposed Action on terrestrial communities in the study area will be from construction of new gravity sewers and force mains and to replace existing sewers. All vegetation will be removed from the pipeline trench sites; additional clearing will be required on either side of the trench to accommodate construction materials and equipment. The amount of clearing will vary according to pipe width, depth of trench, terrain and access to the site. In general, a width of ten feet is required for the trench, with an additional 20 to 30 feet for construction easements. A permanent easement, ten feet wide, will remain for maintenance purposes. The most significant impact will be the clearing and/or disturbance of plant communities that border the channels and drainage ways along which gravity sewers are placed. Since significant effects on development are not associated with the choice of a wastewater management alternative, secondary impacts on vegetation and wildlife are not anticipated. (See socioeconomic consequences.)

The Proposed Action will require such clearing and disturbance along approximately 14 miles of pipeline in the Missouri River floodplain and 18 miles in the Creve Coeur and Fee Fee Creek watersheds, but none in the Bonhomme Creek watershed. The total area required for the pipeline corridor in the Missouri River floodplain will be approximately 17 acres for the trenches themselves and an additional 34 acres for construction access and equipment movements. The pipeline corridor is located along a railroad right-of-way or parallel to an existing roadway, where much of the area is open or cultivated land. The need for clearing is, therefore, much lower in this area. Some grasses, forbs, weedy growth, shrubs and saplings will be removed for trench construction. However, this vegetation will become re-established within three to five years.

Fee Fee Creek Watershed. In the Fee Fee Creek watershed, approximately four acres will be cleared of vegetation to construct the 3.3 miles of pipeline corridor, with an additional 8 to 12 acres to be disturbed by pipeline construction activity. The plant communities which will be affected are highly fragmented and disturbed by existing development. Species such as willows, cottonwood, box elder and silver maple dominate the overstory of the one to three wooded acres which will be cleared. An additional one to two acres along streams will be cleared, including species such as sumac, black cherry, nettle, honeysuckle, rose and other brambles. One-half acre or less of old fields, pasture or cultivated land will also be cleared, the remaining two to six acres consisting of developed land. None of the areas to be affected support diverse wildlife populations.

Creve Coeur Creek Watershed. Approximately 13.4 miles of pipeline will be constructed in the Creve Coeur Creek watershed. The pipeline corridor will require the clearing of approximately 16.2 acres and construction activity will disturb an additional 32.4 to 48.5 acres. Pipelines will be placed along Creve Coeur Creek and its Smith Creek tributary, which are largely bordered by relatively intact woodland of highly variable width. These borders vary from disturbed communities thick with weeds, shrubs and young trees to older floodplain forest with well-developed canopy, subcanopy, and understory. Approximately 5 to 14 acres of woodland will be cleared, including mostly bottomland species such as sycamore, hackberry, elms, silver maple, cottonwood and willows. Mulberry, dogwood, redbud, hickory and mixed oaks are also likely to be affected. Four to eleven acres of old field, pasture, or cultivated land will be cleared, as will four to eleven acres of edge areas along wooded stream borders. The remaining four to twelve acres is located in developed areas.

There are several areas where floodplain forest, old field and slope forest meet to form habitat areas with a diversity of food resources, cover, access to water, materials and sites for nesting, and are of sufficient size to support wildlife. Construction activity which removes a significant portion of an already small band of timber along stream channels will eliminate that area's value as wildlife habitat. Existing animal populations will be reduced or eliminated in cases where no suitable, available habitat can be found or the species cannot disperse to other areas. However, in many areas certain animals may find temporary refuge nearby, and return following the short duration of construction at any site. The ecological possibilities are extremely complex, and the exact ultimate effects are not readily predictable.

After construction, grasses, forbs, shrubs, and saplings will become re-established and capable of supporting wildlife. The value of such areas will depend upon surrounding land uses, disturbance, available habitat and other such considerations. If natural succession is allowed to continue, early bottomland species will become established in five years and communities comparable to what exists now within approximately 30 years. Table 17 presents acreage requirements for the various habitat types.

Certain specifications deal directly with the issue of stream channels and the mitigation of impacts of sewer construction in close proximity to streams. One such specification provides that:

> No surplus or excess materials shall be deposited in any stream channel nor in any place where pre-construction surface drainage would be changed...

and further, that:

> The Contractor will be required to protect existing banks that are to remain undisturbed. Areas damaged by construction equipment shall be restored to the original conditions as nearly as possible by filling ruts, sowing grass seed, and removing and replacing damaged trees or shrubs.

The Project Specifications or Project Plans prepared by MSD would specify the areas to be sodded and seeded. Where sodding would be selected as a restoration technique, the following regulations would apply:

> After restoration of settled surfaces of the trench with earth, or the filling of rutted areas damaged by the Contractor's equipment, all

Table 17

HABITAT AREA TO BE AFFECTED BY PROPOSED ACTION OR SUBREGIONAL ALTERNATVE

(acres)

	Clearing (Within Permanent Ten-Foot Easement)	Other Disturbance (Within Construction Easement)
Fee Fee Creek Watershed		
Woodland	1.0	2.0 to 3.0
Open land	.17	.34 to .50
Edge areas	.73	1.5 to 2.2
Development	2.1	4.2 to 6.3
Creve Coeur Creek Watershed		
Woodland	4.8	9.6 to 14.3
Open land	3.7	7.4 to 11.2
Edge areas	3.8	7.6 to 11.4
Development	3.9	7.8 to 11.6

Notes:

1. Woodland--mostly bottomland and slope species adjacent to stream channels, or upland species next to drainage areas which do not flood.
2. Open Land--including old fields, pasture land and cultivated land.
3. Edge Areas--consisting mostly of shrubby transitions between woodland and old fields, or transitions between thin wooded stream borders and yards, lawns or development.
4. Development--Containing some spacious yards, lawns and plant materials of value to urban tolerant species.

> areas will be sodded. They shall be finegraded and raked to a smooth even surface, approximately one inch below the required finished surface with smooth transitions to adjacent undisturbed areas. Commercial fertilizer shall be uniformly distributed and raked into the prepared surface at the rate of eight pounds per one-thousand square feet. Unless otherwise specified, the fertilizer shall be a standard commercial product with a minimum composition of 4 percent available nitrogen, 12 percent available phosphates, and 4 percent potash. The sod shall be laid with closely-butted joints on the prepared, finished, fertilized moist subgrade; rolled and thoroughly watered; and kept moist until acceptance of the work in lawn areas. The sod to be used shall be bluegrass, free from weeds, leaves, debris and excessive amounts of decomposed vegetable matter. It shall be surface clipped in the field to a two-inch grass height; be in strips of uniform width cut with straight edges and ends; be approximately twelve inches wide and three to five feet long; have an adequate root system not less than one inch thick; and be fresh cut, moist, and in good condition.

Where seeding would be selected:

> If required on the Project Plans or in the Project Specifications that seeding is to be used instead of resodding for specially designated areas, such areas shall be finegraded and raked to the required finished surfaces and grades, and fertilized as described for sodding. Unless otherwise provided in the Project Specifications, seed to be used shall be a good grade of suitable mixed lawn grass, approved by the State of Missouri for viability and freedom from excessive amounts of weed seeds. Such approved seed mix shall consist of: (1) Kentucky Blue Grass, not less than 65 percent; (2) Red Fescue, 15 percent; (3) Red Top, 5 percent; (4) Annual Rye, 15 percent.
>
> It shall be evenly sown on the prepared, moist, fertilized surface at the rate of four pounds oer one-thousand square feet, lightly raked, and covered with pulverized straw, rolled, watered with a fine spray to avoid washing of the seed, and kept moist until acceptance of the work.

Rare and Endangered Species. None of the habitats affected by wastewater management alternatives are known to support rare and endangered species of plants, vertebrates, or invertebrates (except elms which are threatened by disease, as explained below). Several species of rare and endangered plants including *Carex douglii*, *Carex schweinitzii*, *Aster commutatus*, and *Xanthium spinosum* occur along railroad tracks. Construction of a force main along railroad right-of-way in the floodplain will be required by the proposed action; however, this land has been cultivated all the way up to railroad embankments in much of the affected area.

The only rare and endangered plant species known to occur in the St. Louis County area in habitat types affected by the Proposed Action or Alternatives would occur in low woods along streams or in the fields and waste areas. These species include: Carex gracillima, Prenathes racemosa, Boltonia asteroides (var. decurrens), Orobanche ludoviciana, Distichlis stricta, Matricaria maritima, and Stachy hyssopifolia. None of these species were identified during field investigations and, according to the Missouri Department of Conservation, there are no recent recorded sightings within the study area. American elms (Ulmus americana), which frequently occur along streams, are considered to be endangered due to decimation by Dutch elm disease, but this problem is not related to the selection of a wastewater management alternative.

Four federally-designated endangered wildlife species could potentially occur in the project area. In accordance with requirements of the Endangered Species Act, the Environmental Protection Agency has conducted a biological assessment which evaluates the possible effect of the proposed project on the four endangered species. Based on the results of the biological assessment, it was concluded that the proposed project will not affect the federally-designated endangered species. The reasons for reaching this conclusion are discussed below on a species-by-species basis:

1. Haliaeetus leucocephalus alascensia, the northern bald eagle, migrates through Missouri, wintering along large rivers and impoundments where sufficient riparian woods and unfrozen waters for hunting are available. The Midwinter Eagle Survey conducted by the USFWS in 1979 listed six bald eagles along the Missouri River between Hermann and St. Louis. None of the activities required by the Proposed Action or Alternatives will disturb areas along the Missouri River which would be utilized by bald eagles.

2. Falco peregrinus, the peregrine falcon, may migrate through the St. Louis area during spring and fall and is seen in Missouri usually in association with waterfowl and shorebird concentrations. None of the activities required by the Proposed Action would affect areas of importance to the peregrine falcon.

3. Myotis sodalis, the Indiana bat, utilizes caves during the winter and riparian woods for foraging or raising young in colonies in hollow trees. There are no caves in the study area and most of the riparian woodland is highly disturbed and unlikely to support populations of this species. Suitable foraging habitat will remain available to this species within the study area and large mature trees along streams which could harbor young will be avoided during construction.

4. Myotis grisescens, the Gray Bat, requires caves throughout the year for hibernation and for nursery colonies. Large streams with dense riparian woodlands are preferred for foraging. No suitable habitat exists in the study area to support populations of this species.

Beyond the MSD specifications and regulations, certain additional means of mitigating adverse ecological impacts would be available. For example, construction near streams where fish are believed to spawn may be scheduled for middle to late summer. Coordination with the Missouri Department of Conservation and/or the employment of an urban biologist or forester may be helpful in such areas as the determination of the most desirable plantings and other restoration, to restore preconstruction conditions as a minimum but if possible to result in habitat improvement.

Prime Agricultural Land. During construction of the Proposed Action or Subregional Alternative, or maintenance activities (which may be particularly extensive with the No Action Alternative's deteriorating sewer system), a minor but undetermined amount of prime agricultural land would be disturbed. However, the impact in terms of lost crop production (e.g., of corn or soybeans in the Missouri River floodplain) would be small, generally affecting no more than a single harvest of a limited area.

The Proposed Action would also require the extension of the Missouri River Wastewater Treatment Plant's flood protection levee to encompass 21 acres of additional prime agricultural land in the Missouri River floodplain. The Subregional Alternative would similarly require the inclusion of such land, in this case, about 6 acres. In both cases, crop production from the land would be eliminated.

Air Quality

The air quality impacts of construction of the Proposed Action and the Subregional Alternative were evaluated through the use of air pollutant exhaust emission factors for construction equipment. Only nitrogen oxides (NO_x) would be exhausted in substantial quantities as a result of the construction of the Proposed Action (133 tons of NO_x) or the Subregional Alternative (124 tons of NO_x). Existing ambient levels of nitrogen dioxide are well within standards, and no air quality problem is anticipated. The emissions of other exhaust pollutants would be less than 25 tons in each case, an amount which is considered to be insignificant.

During the construction of either the Proposed Action or the Subregional Alternative, considerable quantities of dust could be generated. Some temporary and mostly localized increases in the existing, marginally acceptable levels of particulate matter would be anticipated.

In the case of the No Action Alternative, air pollution in the form of odorous contaminants (such as hydrogen sulfide gas) would continue to occur near the existing, inefficient and overloaded collection and treatment facilities, and polluted receiving waters. This problem would be largely eliminated with either the Proposed Action or the Subregional Alternative.

Air quality impacts of the alternatives being considered may be reduced by various measures. Dust control may be effected by the containment of finely-divided materials during hauling, handling, and storage. Emissions of smoke may be reduced by the proper operation and maintenance of mobile and stationary combustion equipment. Occurrences of odor problems may be reduced by the proper operation and maintenance of wastewater collection and treatment facilities, and solid waste treatment and disposal facilities. Dust problems could be reduced through the use of suitable mitigating measures, such as by spraying water on dry areas, covering finely divided materials in transport and storage, and maintaining clear roadways.

Overall, the Proposed Action and Subregional Alternative would involve increased short-term emissions during construction, but would benefit long-term air quality by eliminating most of the odor problems associated with the existing system and the No Action Alternative.

Noise

The construction of either the Proposed Action or the Subregional Alternative would result in noise impacts during construction, primarily due to the operation of a wide variety of mobile and stationary equipment. The noise sources could include such items as augers, backhoes, compactors, compressors, cranes, derricks, dozers, drills, dump trucks, flatbed trucks, generators, graders, jackhammers, loaders, pile drivers, pipe layers, pumps and scrapers. However, the treatment plant construction would not be located near noise-sensitive receptors, and collection system construction at any location would ordinarily be of short duration (perhaps two weeks).

Noise impacts of any of the alternatives being considered may be reduced by such measures as the use of well-designed, continuously operated and properly maintained absorbers, mufflers, and silencers; maintenance to prevent rattling and vibration; providing barriers, enclosures or housings; and restricting the hours and locations of operations that generate excessive or unusual noise levels.

The Metropolitan St. Louis Sewer District intends to limit construction to daylight hours and to provide advance public notification of all blasting operations in order to minimize inconvenience to the local population.

The operation of wastewater collection and treatment facilities would not be anticipated to result in significant adverse noise impacts for any of the treatment alternatives under consideration.

Energy

Proposed Action. The energy impacts of the wastewater management alternatives were evaluated by annualizing construction energy over a 20-year design life, and adding operational energy. The results of the analysis are summarized in Table 18.

Construction of the Proposed Action would require 540 billion Btu, including 146 billion Btu of petroleum-derived energy needed to fuel construction equipment, produce asphalt, haul materials, etc. Operational energy requirements would include 6.4 million kwh annually for the Creve Coeur/Fee Fee area, 0.6 million for Bonhomme/Caulks floodplain area, and 0.8 million for the Bonfils area, resulting in a total of 7.8 million kwh (or 78 billion Btu of fuel) annually. Based on the design life of 20 years, the annualized energy consumption would be 105 billion Btu, which is less than 10 percent above the existing energy consumption rate (even with the substantially increased wastewater flow), but almost 30 percent below the No Action Alternative rate. This reduction is attributed to the proposed use of an in-plant electric generator, and building and digester heaters, fueled by the gas that would be recovered from the anaerobic digesters. However, the Proposed Action would result in the consumption of 27 billion Btu of petroleum energy (equivalent to 216,000 gallons of gasoline) per year of its 20-year design life.

Table 18

SUMMARY OF ANNUALIZED ENERGY IMPACTS
(10^9 Btu/yr)

Lower Missouri River Basin Study Area

Alternative (year)	Construction(1)	Operation(2)	Life Cycle(3)		
			Petroleum	Non-Petroleum	Total
Existing (1979)	0	96	0	96	96
No-Action (2000)	0	143	0	143	143
Subregional (2000)	17	134	6	145	151
Proposed Action (2000)	27	78	7	98	105

(1) Annualized construction energy is determined by dividing the total energy required to construct by an assumed 20-year useful life.

(2) Operation energy, which is almost entirely electrical, is non-petroleum (that is, assumed to be generated from coal or nuclear fuel).

(3) Life-cycle energy is determined by adding the annualized construction energy and the operational energy.

Subregional Alternative. Construction of the Subregional Alternative would require 337 billion Btu, including 116 billion Btu of petroleum energy. Operational energy requirements would include 10.3 million kwh annually for the Creve Coeur/Fee Fee area, 2.3 million for the Bonhomme/Caulks/floodplain area, and 0.8 million for the Bonfils area, resulting in a total of 13.4 million kwh (or 134 billion Btu of fuel) annually. Based on a 20-year design life, the annualized energy consumption would be 151 billion Btu, which is almost 60 percent above the existing energy consumption rate (because of the substantially increased flow), and about 10 percent above the No Action Alternative rate (because of assumed treatment process improvements which could include primary clarification, fine bubble diffusers, feedback compressor-motor controls, and variable-speed power supplies).

The annual energy consumption rate of the Subregional Alternative is more than 40 percent above the Proposed Action rate because of the lack of major in-plant digester gas utilization. The Subregional Alternative would result in the consumption of 17 billion Btu of petroleum energy (equivalent to about 136,000 gallons of gasoline) per year over the 20-year design life.

No Action Alternative. The No Action Alternative would require no construction energy, and operational energy of 10.8 million kwh annually for the Creve Coeur Creek and Fee Fee Creek areas, 2.3 million for the Bonhomme Creek/Caulks Creek/Missouri River floodplain areas, and 1.2 million kwh for the Bonfils area, resulting in a total of 14.3 million kwh annually. This energy use would require about 143 billion Btu of fuel to be used for the generation of electricity. The anticipated increase of almost 50 percent above existing energy usage (96 billion Btu annually) would result from increases in pumpable and treatable (dry day) flows, and the operation of the Caulks Creek Interim Wastewater Treatment Plant which is currently undergoing final design.

In conclusion, because of anticipated increased wastewater flows to be pumped and treated, each alternative would result in an increase over the existing rate of energy consumption. The increase with the Proposed Action would be small. The increases associated with the No Action and Subregional Alternatives would be about the same, and are considered to be significant. Regarding petroleum-derived energy only, the Subregional Alternative would increase annualized consumption by the equivalent of 136,000 gallons of gasoline per year, and the Proposed Action by 216,000 gallons per year, while the No Action Alternative would have no effect.

Solid Waste

If no action is taken to upgrade wastewater collection and treatment facilities, growth in wastewater flows to the existing system will result in the generation of about 2,700 tons per year of digested sludge and 1,200 tons per year of grit and screenings by the year 2000. If the Proposed Action were implemented, the quantities would be 3,400 tons per year of sludge and 960 tons per year of grit and screenings. If the Subregional Alternative were implemented, the quantities would be 3,800 tons per year of sludge and 2,100 tons per year of grit and screenings.

The selection of a wastewater collection and treatment alternative would not determine the disposition of generated solid waste. This material would instead be handled in accordance with MSD's Solid Waste Management Study and plans yet to be demonstrated, adopted and implemented. The study recommends a demonstration project involving land application of sludge by subsurface injection in the area of the Missouri River Wastewater Treatment Plant. Such a disposal method may be implemented following a demonstration of engineering and environmental feasiblity. Sludge management alternatives also include incineration with energy recovery, if provided for in the Bi-State Development Agency's regional solid waste program, or landfilling in the existing lagoons (which have a capacity far exceeding project requirements) until a satisfactory long-term disposal method becomes available. In any case, grit and screenings would be hauled by truck to the Metropolitan St. Louis Sewer District's Lemay facility for incineration, and landfilling or other disposal of residues.

Because of the availability of these solid waste management alternatives, (though the best has not yet been selected) no significant adverse environmental impacts are anticipated to result from the generation of digested sludge, grit, and screenings. If no alternative solid waste management approach proves to be superior, MSD may continue to employ its on-site lagoons for sludge disposal with no known threat to the environment.

Socioeconomic Environment

Population and Land Use

Based upon analysis of rates of increase in population and development in the study area, the process of infill development would not be significantly affected by any of the proposed alternatives. The study area population is expected to increase to about 106,000 persons, following a geographical distribution similar to the existing pattern.

There will not be any acceleration in the rate of development as a result of the Proposed Action. The projected average annual rate of development between 1980 and 2000 with the project would be only one-fifth of that which occurred between 1970 and 1980. This indicates that extensive growth has occurred in the Creve Coeur Creek and Fee Fee Creek watersheds in the absence of adequate sewage collection and treatment facilities. The factors which appear to be most important in generating growth in the area are: (1) the general trend in increased number of households formed as a result of the maturing population from the "baby boom" years; (2) the increase in employment opportunities in St. Louis County and; (3) the proximity of vacant land in these watersheds to the employment locations.

Similarly, any change in household size or population density would continue to be attributable primarily to changes in household composition and housing demand reflecting the general socio-economic changes in St. Louis County and the St. Louis metropolitan area.

Infill Development. The process of infill development will result in an increase in the proportion of developed land in the two watersheds. However, much of this residential development and virtually all of the non-residential development will occur in areas already platted or committed to development under approved plans. Only five percent of the Fee Fee Creek watershed and 15 percent of the Creve Coeur Creek watershed consist of developable vacant land outside platted and committed areas.

The process of infill development would not be significantly affected by either of the alternatives to the Proposed Action. The No Action Alternative would permit the past decade's trends in development to continue. The rapid development of the two watersheds is expected to proceed regardless of any program to upgrade wastewater collection and treatment facilities. The required extensions of other public services in those already urbanized areas would be relatively small in magnitude, and generally gradual.

Induced Growth. There are two areas where a potential for induced growth should be considered in relation to the Proposed Action and Alternatives. The Bonhomme Creek watershed is presently characterized by scattered low-density residential development with residential acreage in 1978 accounting for only 13 percent of the total watershed area. The Missouri River floodplain consists predominantly of non-urban land uses, with only scattered uses of a more intensive character, including public and commercial recreation, two airports, the St. Louis County Correctional Institution, and water and sewage treatment plants. Residential use is also scattered, totaling less than 100 acres in the floodplain. The only concentrated area of urban non-residential development is the industrial park adjacent to the Spirit of St. Louis Airport. The potential exists for extension of urban development into these areas with resulting changes in character of land use and need for public services. The Proposed Action may facilitate or stimulate further development of the two areas, or of the Caulks Creek watershed, if the Caulks Creek Interim Wastewater Treatment Plant is not permanently abandoned upon the completion of the Proposed Action. This promotion of development would not occur with the Subregional or No Action Alternative.

Bonhomme Creek Watershed. Neither the Proposed Action nor its Alternatives include the extension of sewer service in the Bonhomme Creek watershed. The projected 1980-2000 increase in dwelling units from 207 to 294, and in population from 599 to 652 persons, implies a continuation of the area's low density, non-urban character. This growth would result in a total projected wastewater flow of 80,000 gallons per day, which could be handled by individual treatment systems.

The Land Use Plan adopted by St. Louis County indicates the possibility of residential development of an urban character in the northern portions of the Bonhomme Creek watershed. While this residential classification is very broad in character, encompassing development with a density as low as one dwelling per acre, the possibility of development at a higher density exists under this designation. Experience in other portions of the Lower Missouri River Basin, especially in the adjacent Caulks Creek watershed, has indicated that a lack of coordinated sewer facilities does not prevent rapid growth. Should future residential development in portions of the Bonhomme Creek area be urban and concentrated rather than non-urban and scattered in character, the problems of providing public services including adequate wastewater collection and treatment facilities will arise.

Missouri River Floodplain. The Missouri River floodplain area is designated in the County Land Use Plan for industrial use, along with the remainder of the Chesterfield Valley area south of U.S. Route 40, which consists of over 3,000 acres. In addition, the Land Use Plan designates a portion of the floodplain area adjacent to Creve Coeur Lake as an area that "requires additional study." The area's Stage I Feasibility Study recommends the development of a 250-acre office park, as well as a fairground and stadium, and a 950-acre industrial park adjacent to the study area delineated in the Land Use Plan. The county has not officially adopted the recommendation, and the area remains under study. Neither the Proposed Action nor the Alternatives would provide service for the recommended development.

The Proposed Action and Subregional Alternative include facilities to serve existing development in the vicinity of the Spirit of St. Louis Airport, and would also provide capacity for the additional industrial development of approximately 160 acres in that vicinity. There are several vacant parcels in and adjacent to the existing industrial park which would most likely be the areas served by the additional capacity proposed. Because the Proposed Action and Subregional Alternative would provide limited additional capacity to an area with existing and platted development, and partially served by an existing sewer system, the extent to which growth may be induced is not significant. Thus, federal and St. Louis County floodplain development policies need not be considered as applicable to the evaluation of wastewater management alternatives as currently defined. However, should extensive development occur in these areas, additional wastewater collection and treatment, as well as other public services, would need to be provided.

Cultural Resources

Archaeological investigations have been conducted within the study area for the 201 Facility Plan. None of the alternatives would have any adverse impact on significant archaeological sites. No historic sites, buildings, parks or open space areas would be adversely affected by the Proposed Action or the Subregional Alternative. The No Action Alternative would result in continued water quality degradation aesthetically affecting streams, ponds, and lakes and indirectly, parks and open space.

Economics

If no action is taken to improve or expand the existing wastewater management facilities, constant-dollar (1979) operating and maintenance costs may nearly double, to approximately $2.9 million annually by the year 2000. This increase would result from the need to pump and treat greater wastewater flows (though about 30 percent of the flow increase may be bypassed), and to operate and maintain equipment and facilities aging well beyond design life. This $2.9 million annual expenditure is not anticipated to result in adequate wastewater collection and treatment. The indirect costs of continued sewer backups and water pollution have not been quantified, but would add to the total cost of the No Action Alternative.

The cost of construction for the Proposed Action (reduced to reflect the revised required capacity of 23 mgd) would be $44.3 million, including $8.9 million for a sewer line from the Bonfils Creek area to the new Missouri River Wastewater Treatment Plant. (See Table 19.) The operating cost of $2.0 million would be greater than the current level, but lower than that for the No Action Alternative. The total annualized cost of the Proposed Action would be about $6.3 million per year. (See Table 20.)

The cost of construction of the Subregional Alternative, including the replacement of all major mechanical equipment and the addition of primary clarification and fine-bubble diffusers, as well as the construction of a permanent rather than interim Caulks Creek treatment facility, would be about $40.6 million. (The MSD's Facilities Plan included a greater cost for a greater capacity addition, and a change from contact stabilization to conventional step aeration.) The operating cost would be about $2.2 million per year, assuming that the currently excessive aeration and maintenance costs would be reduced to a level only slightly above those associated with new treatment plants having coarse bubble diffusers and no digestor gas energy systems. The cost to MSD and its customers would thus be slightly increased. However, the annualized cost of

Table 19

ESTIMATED CONSTRUCTION COSTS OF WASTEWATER MANAGEMENT ALTERNATIVES
(in millions of 1979 dollars)

Item	Proposed Action	Subregional Alternative
New Treatment	$24.7	$16.8
New Collection and Transmission	10.7	8.9
Upgrading		
Activated sludge system	—	2.0
Aerobic digestion process	—	1.3
Primary clarification (to be added)	—	1.1
Secondary clarification	—	0.8
Control building equipment	—	0.5
Fine bubble diffusion (to be added)	—	0.3
Sewer Line from Bonfils Creek Area	8.9	8.9
	$44.3	$40.6

Table 20

ECONOMIC COMPARISON OF WASTEWATER MANAGEMENT ALTERNATIVES
Lower Missouri River Basin Study Area

(in millions of 1979 dollars)

Alternative	Construction Cost	Operation & Maintenance Cost (per year)	Annualized Cost[a] (per year)
Existing Conditions	—	1.5[b]	1.5
No Action	—	2.9[c]	2.9
Proposed Action	44.3[d]	2.0[b]	6.3
Subregional	40.6[d,e]	2.2[f]	6.1

[a] Includes 9.716 percent per year of construction cost (from 7.375 percent per year discount rate and 20-year amortization).

[b] Includes $0.2 million per year for Bonfils and Caulks Creek operation and maintenance.

[c] Includes $0.6 million per year for Bonfils and Caulks Creek operation and maintenance, with a doubling of labor and material costs to account for equipment operation beyond design life.

[d] Includes $8.9 million to construct a Bonfils Creek sewer line to the Missouri River Wastewater Treatment Plant.

[e] Includes $22.8 million to upgrade and double the capacity of the Missouri River Wastewater Treatment Plant, $1.0 million for the substitution of a permanent Caulks Creek plant for an interim plant, and all proposed collection and transmission improvements except construction of a Caulks Creek force main to the Missouri River Wastewater Treatment Plant.

[f] $0.3 million per year for Bonfils and Caulks Creek operation and maintenance, and a 20 percent surcharge on labor and materials to account for difficulties of retaining the tanks and underground piping of the existing Missouri River Wastewater Treatment Plant.

the Subregional Alternative would be about $6.1 million per year, which is $0.2 million per year less than the cost of the Proposed Action, or the equivalent of about $2.1 million less in capitalized cost, after accounting for the operational savings. However, in consideration of the uncertainties inherent in such cost estimates, the difference in cost estimates is insignificant. Furthermore, potential economic differences that have not been quantified (further energy savings of up to $0.3 million annually if fine bubble diffusers are incorporated in the Proposed Action; increases in constant-dollar energy costs which would add more to Subregional Alternative operating expenses; unexpectedly high costs for interfacing new and existing Subregional Alternative facilities; and differences in salvage values which may be expected to be greater with the Proposed Action) may alter the economic balance in favor of the Proposed Action.

See Appendix B for correspondence from the St. Louis Metropolitan Sewer District to EPA regarding an additional viewpoint on these economic matters.

SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

The Proposed Action and Subregional Alternative would each involve short-term uses of geological, hydrological, atmospheric, aquatic, terrestrial, energy, and economic resources for the construction, operation and maintenance of wastewater collection, transmission, and treatment facilities. With appropriate mitigation, the magnitudes of short-term impacts range from moderate to insignificant, because of their generally localized and reversible characteristics.

Either the Proposed Action or the Subregional Alternative would offer long-term protection of the environment in the area water quality and aquatic resources. Either action would also reduce the health hazards and objectional aesthetic aspects of water pollution. In addition, the Proposed Action would help to conserve total energy resources (though consuming more petroleum-derived fuel than the alternatives).

In the case of the No Action Alternative, the use of the capacity of the aquatic, terrestrial and social environment to absorb the impacts of excessive and incompletely treated wastewater flows would continue, to the possible detriment of the long-term maintenance of environmental quality and productivity.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS

Either the Proposed Action or the Subregional Alternative would involve few irreversible and irretrievable committments of resources. Less than 60 acres of land would be cleared for construction, including prime agricultural land at the treatment plant's floodplain site (21 acres with the Proposed Action, or six acres with the Subregional Alternative), less than six acres of stream-side woodland, five acres of woodland edge areas, and four acres of open land.

The construction of the Proposed Action would also result in the consumption of a variety of resources including the equivalent of over four million gallons of petroleum-derived fuel, and would cost about $47.3 million (including a sewer from the adjacent Bonfils Creek area). The existing Missouri River Wastewater Treatment Plant would be dismantled, and the Caulks Creek Interim Wastewater Treatment Plant would be scheduled for abandonment.

The construction of the Subregional Alternative would involve resource consumption including the equivalent of less than three million gallons of petroleum-derived fuel (though total energy consumption would be greater than with the Proposed Action) and would cost $38.3 million (also including the Bonfils sewer). The existing Missouri River Wastewater Treatment Plant would be upgraded and, along with the Caulks Creek Wastewater Treatment Plant, would be retained as part of the wastewater management system.

The No Action Alternative involves no irreversible and irretrievable commitments of resources, other than the continuation of high energy consumption (in comparison to that of the Proposed Action) and the possibility that worsening pollution may lead to long-term environmental harm (e.g., the toxification of stream bottom sediments).

COORDINATION AND PUBLIC PARTICIPATION

During the preparation of this DEIS, the interagency coordination and public participation begun in the facilities planning process and was continued in the DEIS process. Coordination was accomplished through communications with the U.S. Department of the Interior's Fish and Wildlife Service, the Missouri Departments of Conservation and Natural Resources, the St. Louis County Department of Planning, and others.

In order to inform the public of the ongoing study, newsletters were printed and distributed, and two public meetings were held following distribution of the newsletters. Twenty-nine persons attended the first public meeting held April 7, 1981. Early evidence of continuing concern about the urgent need for the Claymark Interceptor led to its exemption by segmentation from the EIS process. As an apparent result of this action, the attendance at the second meeting on May 12, 1981, was less than that at the first meeting.

PREPARERS

Name	Organization	Disciplinary Area	Experience (years)
Ronald Alderfer, Ph.D.	ES&E	Biological Environment	10
Beshid Bahrami	S&W	Geology	17
Scott Cantine, A.I.P.	HB&A	Social Environment	20
Robert Cutler, P.E.	HB&A	Physical Environment	9
Angela Davis	HB&A	Biological Environment	6
Rogers Dixson	HB&A	Physical Environment	4
Robert Duchek, A.I.P.	HB&A	Social Environment	13
Richard Keating	HB&A	Physical Environment	2
Daniel Lang	HB&A	Biological Environment	4
Donovan Larson, P.E.	HB&A	Wastewater Treatment	8
Eldridge Lovelace, A.I.C.P., A.P.A.	HB&A	Social Environment	46
Donald McQueen, C.P.G.	S&W	Geology	11
Wayne Montgomery, P.E.	HB&A	Wastewater Treatment	12
Mary O'Donnell	EPA	Environmental Assessment	7
John Rockaway, Ph.D.	S&W*	Geology	18
Jerome Westphal, Ph.D., P.E.	S&W*	Hydrology	16

Note:

EPA - Environmental Protection Agency
ES&E - Environmental Science & Engineering, Inc.
HB&A - Harland Bartholomew & Associates, Inc.
S&W - Shannon & Wilson, Inc.
* - Private Consultant to indicated organization

APPENDIX A

ANNUAL WIND ROSE

ST. LOUIS, MISSOURI
ANNUAL WIND ROSE - ALL CLASSES
3-HOURLY DAY DATA 1970-1974
OBS - 14,600

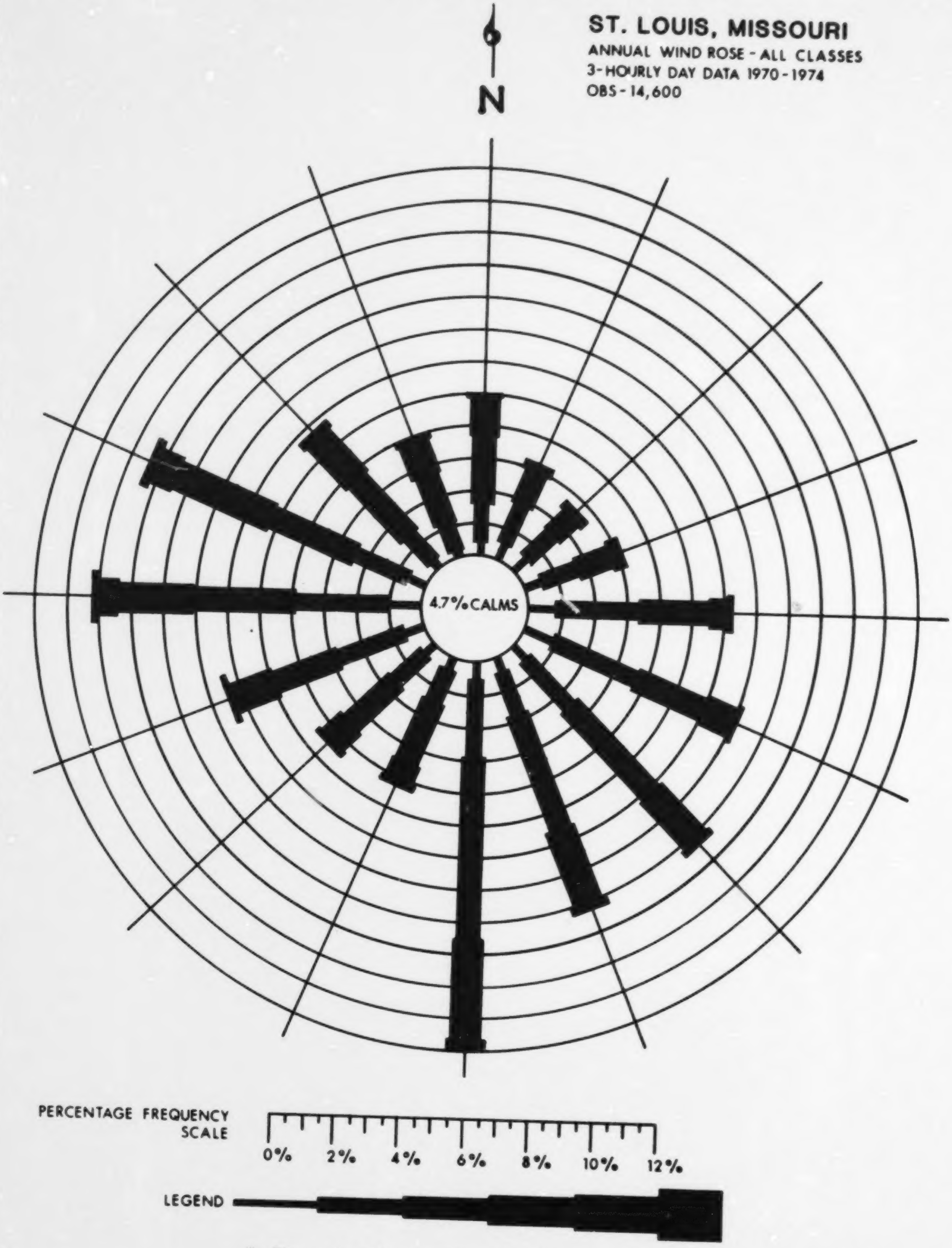


PLATE A-1

Table A-1

GENERAL STRATIGRAPHIC COLUMN

Lower Missouri River Basin Study Area

Beginning Millions of Years Ago	Period	Geological Formation	Thickness (feet)	Dominant Lithology
1	Quaternary	Pleistocene Series	0-100±	Till, alluvium, and loess
70	Tertiary	Pliocene Series	0-10±	"Lafayette" (Grover) gravels
300	Pennsylvanian	Pleasanton Group	0-100±	Sandstone, shale
		Marmaton Group	0-75	Limestone, shale, coal
		Cherokee Group	0-100	Shale, sandstone, coal
350	Mississippian	Cheltenham	0-30	Clay (refractory)
		Ste. Genevieve	0-50	Limestone, sandy, oolitic
		St. Louis	200+	Limestone, lithographic
		Salem (Spergen)	100-175	Limestone, dolomite, cherty
		Warsaw	70	Shale, limestone, cherty
		Keokuk		Limestone, cherty
		Burlington	200±	Limestone, cherty
		Fern Glen	0-60+	Limestone, cherty, shaly
		Chouteau	5-80	Limestone, dolomite, argillaceous
		Bachelor	1±	Sandstone, phosphatic nodules
400	Devonian	Sulphur Springs Group		
		Bushberg	5-50±	Sandstone
		Glen Park	0-30	Limestone, oolitic (basal shale)

Table A-1
(continued)

Beginning Millions of Years Ago	Period	Geological Formation	Thickness (feet)	Dominant Lithology
		Subsurface		
440	Silurian	St. Louis County	0-150±	Dolomite
500	Ordovician	Maquoketa	0-100+	Shale
		Kimmswick	30-125	Limestone, crystalline
		Decorah	25+	Limestone, shaly, shale
		Plattin	80-150	Limestone, fine, cherty
		Joachim-Rock Levee	60-125	Dolomite, argillaceous shale
		St. Peter	50-150+	Sandstone
		Cotter-Powell	100-300	Dolomite, cherty
		Jefferson City	150±	Dolomite, cherty
		Subsurface only		
		Roubidoux	100-200	Sandstone, dolomite, cherty
		Gasconade	250-300	Dolomite, cherty
600	Cambrian	Eminence	200-450	Dolomite, quartz druse
		Potosi		
		Elvins Group		
		Derby-Doerun	150-400	Dolomite
		Davis	150-400	Dolomite, shale
		Bonneterre	175-375	Dolomite
		Lamotte	0-300	Sandstone
5,000	Pre-Cambrian	——	——	Granite, red quartzite

Reference: Saeger, 1975.

Table A-2

RARE AND ENDANGERED SPECIES FOUND IN THE ST. LOUIS COUNTY AREA

	Scientific Name	Common Name
Endangered Flora	*Asclepias meadii*	Mead's Milkweed
	Carex douglasii	Douglas Sedge
	Carex schweinitzii	Schweinitz's Sedge
	Fontinalis disticha	
	Orobanche ludoviciana	Broom-rape
	Prenathes racemosa	
	Ulmus americana	American Elm
Rare Flora	*Aster commutatus*	White Prairie Aster
	Boltonia asteroides (var. decurrens)	Boltonia
	Botrychium dissectum	Cut-leaved Grape Fern
	Carex praegracilis	Slender Sledge
	Distichlis stricta	Inland Salt Grass
	Habernaria leucophaea	Prairie White-fringed Orchid
	Lithospermum latifolium	Puccoon
	Lycopodium lucidulum	Shining Clubmoss
	Malaxis unifolia	Green Adder's Mouth
	Matelea obligus	Climbing Milkweed
	Peltandra virginica	Arrow Arum
	Polygonum bicorne	Knotweed
	Spiranthes ovalis	
Flora of Undetermined Status		
	Carex gracillima	Graceful Sedge
	Matricaria maritima (var. agrestis)	
	Stachy hyssopifolia	Hedge Nettle
Rare and Endangered Fauna Invertebrates		
	Zosteractis interminata	Millipede, found in caves, St. Louis and Ste. Genevieve Counties
	Pelecypoda spp.	Several species of rare and endangered mussels occur in neaby rivers such as the Meramec, Bourbeuse, River Aux Vases, Gasconade, Salt and Mississippi

Table A-2
(continued)

	Scientific Name	Common Name
Vertebrates		
Endangered Fish		
	Acipenser fulvescens	Lake Sturgeon
	Scaphirynchus albus	Pallid Sturgeon
	Hybopsis gelida	Sturgeon Chub
	Hybopsis meeki	Sicklefin Chub
	Notropis amnis	Pallid Shiner (possibly extirpated)
Rare Fish		
	Lepisosteus spatula	Alligator Gar
	Alosa alabamae	Alabama Shad
Endangered Amphibians		
	Rana sylvatica	Wood Frog
Rare Amphibians & Reptiles		
	Hemidactylium scutatus	Four-toed Salamander
	Opheodrys vernalis	Smooth Green Snake
Endangered Birds--Permanent Residents		
	Buteo lineatus	Red-shouldered Hawk
	Tyto alba	Barn Owl
Endangered Birds--Migratory or Peripheral		
	Phalacrocorax auritus	Double-crested Cormorant
	Accipiter striatus	Sharp-shinned Hawk
	Accipiter cooperii	Cooper's Hawk
	Sterna albifrons	Least Tern
Rare Birds--Migratory or Peripheral		
	Ictinia mississippiensis	Mississippi Kite
	Rallus elegans	King Rail
	Bartramia longicauda	Upland Sandpiper
	Ammodramus henslowii	Henslow's Sparrow
	Aimophila aestivalis	Bachman's Sparrow

Table A-2
(continued)

	Scientific Name	Common Name
Endangered Birds--Non-nesting		
	*Haliaeetus leucocephalus alascensis	Northern Bald Eagle
	Pandion haliaetus	Osprey
	*Falco peregrinus	Peregrine Falcon
Endangered Mammals		
	*Myotis sodalis	Indiana Bat
	*Myotis grisescens	Gray Bat
Rare Mammals		
	Myotis keenii	Keen's Bat
	Mustela frenata	Long-tailed Weasel

* Federally-designated endangered species (proposed or existing)

1. Endangered. An endangered species or subspecies is one whose prospects for survival within the state are in immediate jeopardy. Its peril may result from one or many causes--loss of habitat or change in habitat, overexploitation, predation, competition, disease. An endangered species must have help or extirpation probably will follow.

2. Rare. A rare species or subspecies is one that is present in Missouri in small numbers. If its environment worsens, its continued presence in the state may become endangered. Many of the species listed here as rare in Missouri are present in substantial numbers in other parts of their range, and may never have ranged far into this state or occurred here in substantial numbers. They are listed because their presence enriches and diversifies the state's environment. The designation "rare," as defined here, is not necessarily synonymous with "threatened" as that word is used in federal legislation.

3. Undetermined Status. A status undetermined species or subspecies is one that has been suggested by competent authority as possibly rare or endangered, but about which there is not enough information to determine its status. More information is needed, but it should be considered rare or endangered until its status is more definitely established.

Table A-2
(continued)

Sources: Rare and Endangered Species of Missouri, Missouri Department of Conservation and USDA Soil Conservation Service, 1977.

An Introduction to the Biological Systems of the St. Louis Area, Vol. I, Missouri Botanical Garden, 1974.

Correspondence from Tom Nash, Field Supervisor, Ecological Services, U.S. Department of the Interior, Fish and Wildlife Service, Kansas City MO, August 3, 1981.

Table A-3

METEOROLOGICAL DATA FOR ST. LOUIS, MISSOURI

	Typical Daily Temp. (F)			Degree Days (from 65 F)		Precipitation (in.$H_2$0)			Relative Humidity (%)				Wind	
Month	Max.	Min.	Avg.	Heating	Cooling	Max.	Min.	Avg.	12M	6A	12N	6P	MPH	Dir.
January	40	23	31	1045	0	5.4	0.2	2.2	78	82	65	70	10.4	NW
February	44	26	35	837	0	4.2	0.3	2.3	76	81	62	65	10.8	NW
March	53	34	43	682	9	6.7	1.1	3.3	75	82	58	59	11.8	WNW
April	67	46	57	272	17	9.1	1.0	3.7	70	79	54	53	11.3	WNW
May	76	56	66	103	128	7.3	1.0	4.1	76	83	56	56	9.4	S
June	85	65	75	10	307	8.7	0.5	4.1	78	84	57	56	8.6	S
July	88	69	79	0	422	7.8	0.6	3.3	78	86	57	56	7.8	S
August	87	67	77	0	378	6.4	0.1	3.0	81	89	57	59	7.5	S
September	80	59	70	35	173	6.2	0.8	3.2	83	91	60	63	7.9	S
October	70	48	59	224	41	5.8	0.2	2.7	78	86	56	61	8.5	S
November	54	36	45	600	0	5.7	0.4	2.7	78	85	63	69	9.9	S
December	43	27	35	942	0	6.5	0.3	2.2	81	85	69	75	10.3	WNW
Annual	66	46	56	4750	1475	50.3	20.6	36.6	78	84	60	62	9.5	S

APPENDIX B

METROPOLITAN ST. LOUIS SEWER DISTRICT

MSD

September 18, 1981

U. S. Environmental Protection Agency
Region VII
324 East 11th Street
Kansas City, MO 64106

Attention: Ms. Mary Jeanne O'Donnell

Subject: Lower Missouri River Basin 201 Facility Plan EIS

Dear Ms. O'Donnell:

Based on a revised economic comparison of alternatives presented in the EIS, the Metropolitan St. Louis Sewer District and its consultant, Sverdrup & Parcel, believe that the regional step aeration treatment plant (proposed action) is more cost-effective than the sub-regional alternative.

Table 1, attached, presents our estimate of annual power consumption for the two alternatives. Power costs for the step aeration treatment plant are reduced from those presented in the 201 report to reflect the use of fine bubble diffusers in the aeration basins. Power costs for the sub-regional alternative are increased over those presented in the EIS to reflect aerobic digestion of primary sludge. The step aeration treatment plant results in a power savings of approximately $500,000 per year in 1979 dollars over the sub-regional alternative. Should power costs triple over the life of the plant, the step aeration treatment plant will save $1,500,000 per year by the end of the design period.

Table 2, attached, presents total annual operating costs for the two alternatives. The step aeration alternative results in an annual operating savings of approximately $700,000 per year over the sub-regional alternative. This savings results primarily from the reduction in power consumption, but also from the elimination of the Caulks Creek treatment facility and the increased labor and equipment costs associated with maintaining older tanks and equipment for the sub-regional alternative.

Table 3, attached, presents an economic comparison of the two alternatives. The construction cost of the step aeration plant is reduced by $3,000,000 from that presented in the EIS to reflect the reduction in capacity from 27 mgd to 23 mgd. The construction cost of the sub-regional alternative is increased by $1,000,000 over that presented in the EIS to reflect upgrading the Caulks Creek plant to a permanent facility. The annualized cost of the regional step aeration alternative is approximately $200,000

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less than the sub-regional alternative.

Other factors which should be considered include the following:

1. None of the cost estimates considered the salvage value at the end of the 20 year design period. Consideration of salvage value will improve the cost-effectiveness of the step aeration alternative.

2. The sub-regional alternative requires considerable interfacing of existing and new construction. In a preliminary estimate, it is difficult to determine the cost impact of the interfacing new and existing facilities. Based on previous experience, we believe that a 20% increase in the cost estimate is not unlikely when new facilities are tied into existing facilities. The sub-regional alternative makes extensive use of existing facilities, while the step aeration treatment plant consists almost exclusively of new construction.

3. The site for the Caulks Creek Wastewater Treatment Plant was selected for an interim facility and there is absolutely no room for expansion. Also, the conditional use permit for the treatment plant granted by St. Louis County is for an interim treatment plant.

Very truly yours,

Charles B Kaiser

Charles B. Kaiser, Jr.
Assistant Executive Director
and General Counsel

CBK/kam

Attachments

cc: Scott Cantine (HBA)
Kenneth L. Coble (S&P)

TABLE 1

ANNUAL POWER CONSUMPTION

	$KWH \times 10^6$	$BTU \times 10^9$	ANNUAL COST*
Step Aeration w/ fine bubble diffusers			
Treatment Plant	6.2	21	$248,000
Transmission	1.7	5	$68,000
Credit (Generator)	(4.0)	(13)	($162,000)
TOTAL	3.9	13	$154,000
Sub-regional			
Treatment Plant	11.2	38	$450,000
Caulks Creek Plant	3.5	12	$140,000
Transmission	1.7	5	$ 68,000
TOTAL	16.4	55	$658,000

* @$.04/KWH, 1979 dollars

TABLE 2
ANNUAL OPERATING COSTS
(Millions of 1979 dollars)

	Step-Aeration Plant	Sub-Regional Alternate
Transmission System	.66	.66
Treatment Plant		
Power	.10*	.45*
Labor	.64	.77
Equipment	.20	.23
Misc.	.10	.10
Bonfils	.20	.20
Caulks	-	.20
TOTAL	$1.9	$2.6

* Reflects the use of fine bubble diffusers in the aeration basins.

TABLE 3
ECONOMIC COMPARISON
(Millions of 1979 dollars)

Alternative	Construction Cost	Annual O&M	Total Present Worth*	Annualized Cost*
Step Aeration Plant	$44.3	1.9	65.0 (63.9)**	6.0 (6.2)**
[✓ Sub-Regional System]	$39.3	2.6	67.7 (66.0)**	6.2 (6.4)**

* @ 6 5/8% for 20 years
** @ 7 3/8% for 20 years